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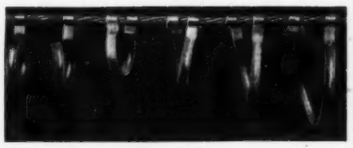

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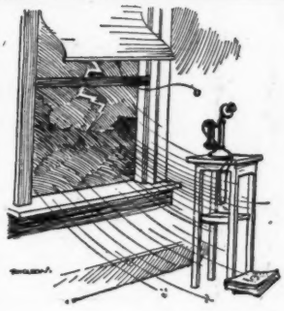

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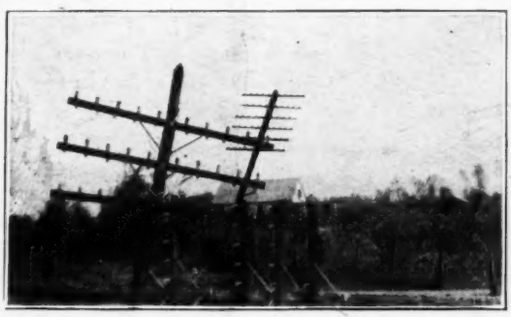

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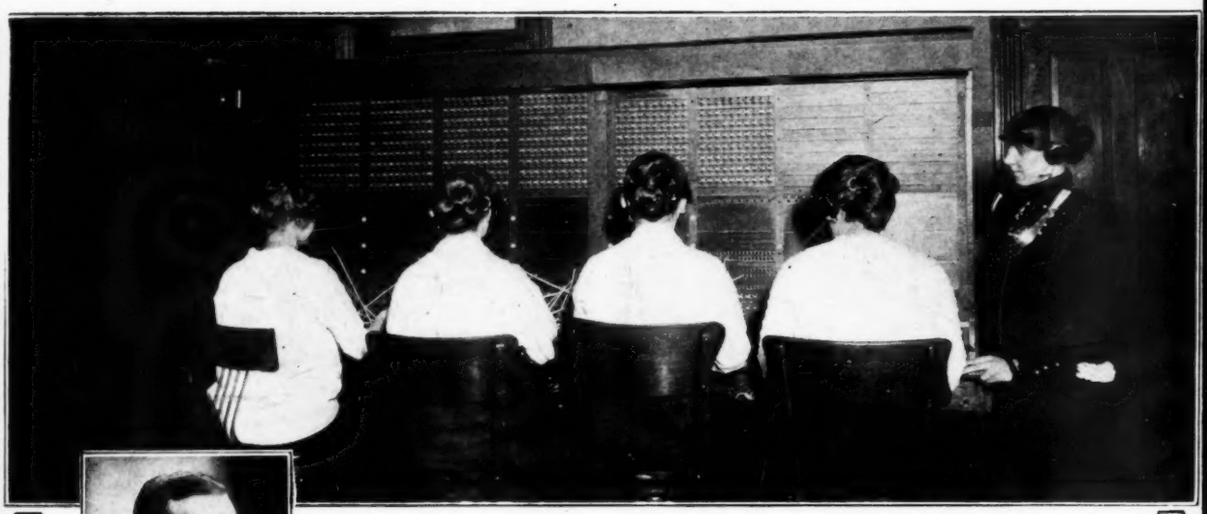

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Telephony.

THE AMERICAN TELEPHONE JOURNAL

Comprising Telephony, American Telephone Journal, Telephone Weekly, Telephone Magazine, Telephone Securities, The Telephone, Sound Wave

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Subscription—10 Cents a Copy
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As Seen from the Inside.

One of TELEPHONY'S readers, in sending in the renewal for his subscription this week, wrote a letter which is especially interesting when it is known that he is a Bell telephone man. For obvious reasons his name and company are withheld, for we don't want him placed at the mercy (?) of an organization that stands sponsor for the species of Bell-Western Electric competition that disgraces the telephone field today.

This subscriber says:

"I have been watching with interest your fight against the Bell-Western Electric. I worked in the ——— department of the Western last year, but am now with the ——— Telephone Co. (a Bell concern). However, in spite of the fact that I am a Bell employe, I think your attitude is a very just one.

The idea of common carriers owning and controlling their manufacturing companies has been strongly condemned in the case of the railroads, and should be equally so in the case of all common carriers. It is a question which I imagine will have to travel through all the courts before it is finally settled, though, so I guess you will have a pretty long fight on your hands."

It may be a long fight, but when men connected with the Bell system admit the justice of the contention, it is bound to be settled and settled right some day.

"Guilty, as Charged."

The thoroughness with which Bell employes comb the telephone field to obtain business for the Western Electric Co. continues to be a matter for surprise, when it is borne in mind the trouble this activity is bringing the Bell organization every day. Not long ago the Valley Home Telephone Co., Saginaw, Mich., wrote an Independent dealer to get prices on anchors. Within a few days a Western Electric salesman called and said he understood that the company was in the market for this kind of supplies. Manager W. B. Serviss was much surprised at this visit, as he had had no communication with the Bell factory. The representative of the Western said that, owing to the fact the Valley Home was competing with the Michigan Bell company, he did not think he could sell them telephones, but that he would be able to sell them anchors, as the Western Electric Co. had notified him that Mr. Serviss was about to buy some.

How did the Western Electric Co. learn of this proposed purchase? The incident reminds one of the time when the Bell owned the Western Union Telegraph Co., and never failed to inform the Western Electric factory of all messages that went over both telegraph and telephone wires regarding prospective purchasers.

Within the last two weeks a Western Electric salesman solicited Independent business from the Florala (Ala.) Telephone Co. At Opp, Ala., the Bell salesman showed up September 8 and tried to sell apparatus to the local Independent company. On September 13 a Western Electric salesman called on the Dunkirk & Fredonia Telephone Co. at Fredonia, N. Y., and made a strong talk to induce the company to give its business to the Bell factory. This salesman said that the Western was not out of the Independent field and took great pains to "knock" Independent manufacturers and equipment. September 7 a Western solicitor called on the Wyandotte County Telephone Co. at Bonner Springs, Kan., seeking business. A report also states that a Western Electric man visited the Sunnyside (Cal.) Telephone Co. and urged the local manager to buy Bell equipment.

At Bellefontaine and West Liberty, Ohio, the Bell factory has had salesmen on the ground who urged the local telephone buyers to hold their orders until the Bell fac-

tory was able to make deliveries. A similar report comes from East Palestine, Ohio, where the Unit Township Telephone Co. was earnestly solicited by a Western salesman who works out of Pittsburgh. Incidentally, it may be said that the Bell price was $96 lower than the Independent manufacturers' price, and the total amount of the job was only $315, at that. As a price maintainer, the Western Electric Co. is certainly a dismal failure, *especially* when *in competition with Independent manufacturers.* It is safe to say that no Bell licensee who is compelled to buy from the Western Electric Co. would be quoted any such attractive figure.

According to information received, Bell factory salesmen have also solicited business recently from Independent telephone companies at Murfreesboro, Tenn., and Bunker Hill, Mo. Word comes from Texas that from its Dallas branch the Western Electric Co. is sending sample telephones to Independent companies and *prepaying express charges.* A four- or five-bar instrument with a battery and protector, is sent unsolicited, and along comes a bill for $11.95 a few days later. In many cases the telephone companies return the samples, *charges collect.*

From Elk Point, S. D., the report comes that a Bell factory salesman called on the local company and solicited common battery business. Another correspondent, writing from Portland, Ore., advises that he talked with a Western Electric representative who said that he understood his company intended to continue to seek Independent trade.

Word comes from Wynot, Neb., also, that a Western Electric salesman called on the local Independent telephone company about three weeks ago, and his principal argument in favor of the Home company buying Bell equipment was that a better price could be obtained in case the local interests ever sold out. The Bell salesman got an order for a 150-line switchboard, and the installation was completed within eleven days thereafter. This rapid work for an Independent company, when Bell licensees are waiting from 90 days to six months for Western Electric deliveries, shows how eager the Bell factory is to break into the Independent field.

From Arizona comes the news that the Bell factory is cultivating Independent trade there with great vigilance. Within the last two weeks Western Electric representatives have solicited the local Independent companies at Miami, Holbrook, Kingman, Oatman, Morenci, Winkelman, Duncan and Clifton, Ariz., and Lordsburg, N. M. They have sent sample telephones and overlooked no possible way to break in on the business belonging to Independent manufacturers. At one of these towns an Independent manufacturer had submitted a price of $208 on a 50-line board and the Bell factory cut that price to $135 and got the business. What matters a loss if the Bell can steal a customer from a rival manufacturer?

September 20 a Western Electric salesman solicited business from the Pitcher (Ill.) Telephone Co. The same day a Bell man called on the Kinmundy (Ill.) Telephone Exchange Co. and tried to sell a switchboard and other material. Other reports show that Bell salesmen have sought Independent business at Hedrick, Ia.; Ogden, Ia.; South Haven, Mich.; Fredonia, N. Y., and De Funiak Springs, Fla.

These reports demonstrate that delays in filling Bell licensee orders do not worry the Western Electric Co. so long as it sees a possible chance to get an order from an Independent telephone company. Of course, the licensees are not entirely happy over the situation, but the real loser in the end is the telephone-using public. As in the recent railroad strike crisis, it is always the public that has to pay the freight.

Proceedings Before Commissions, Courts and Councils

Discussions and Rulings of State Bodies Having Supervision Over Telephone Companies, Decisions of Courts in Matters of Interest to Public Utilities and Actions of City Councils Relative to Franchises, Rates and Service

Ohio State Asks Measured Service for Cleveland.

What is said to be the first effort of an Independent company to give measured service was made October 11 when the Ohio State Telephone Co. filed with the Ohio Public Utilities Commission a new schedule of measured service rates for Cleveland. According to the proposed schedule, measured service will be offered on one, two and four-party circuits, both to business and residence subscribers. Individual line service, measured, will be $2 a month cheaper, limited to 100 calls. Four-party residence service will be 50 cents a month cheaper than at present, limited to 50 calls a month. Extra calls above the number of the contract price are charged at a sliding scale, depending upon the number. The price ranges from 2½ down to 1½ cents per call. Charges are to be made only for outgoing calls. Incoming calls are not registered.

According to Rollo R. Stevens, general commercial superintendent of the company, the changes are intended to cover Cleveland and its suburbs and to give a new and more flexible service. He expects that it will result in a decreased cost to the individual user of a telephone in a majority of cases, but that it will increase greatly the number of instruments in service. It is contended, moreover, that the call is the proper unit of service and ultimately it will become the basis for all charges.

The company recently spent $800,000 in rebuilding its exchange and extending its facilities, and the new rates are for the avowed purpose of popularizing the service.

Right of City to Order Removal of Poles from Streets.

Upon an appeal to the Wisconsin Railroad Commission from an ordinance passed by the common council of Mellen, Wis., requiring the Ashland Home Telephone Co. to remove its poles from two of the main streets, the commission ruled, on October 12, as follows:

"Numerous cities in the state have in recent years required the removal of obstructions in the streets in order to make the streets more suitable for their primary purpose. Such ordinances as the one adopted in Mellen are proper unless they interfere unreasonably with the ability of a utility to render adequate service, or impose upon the utility a burden, which is not consistent with the benefits to be de-

rived by the public by the improvements. In the present case compliance with the ordinance will not impair adequate service and the financial burden can be met by a proper adjustment of rates, if such adjustment becomes necessary to secure to the utility a reasonable return."

This case is a result of a complaint made some time ago relative to the alleged inadequacy of the equipment and service of the Ashland Home company at Mellen. At a hearing on January 27, 1916, the company agreed to make certain additions and improvements and proceeded to do this. In August the council passed the ordinance, mentioned previously, requiring the removal of the company's poles from two main streets, from which ordinance the company appealed to the commission.

The company is ordered to make the improvements required by the city ordinance by January 1, 1917. If the city has not laid out and opened the alleys necessary for the relocation of the poles by January 1, 1917, then the company is allowed to proceed with the work as originally planned.

Directory Listing of Firm Name Brings Suit.

The Nowlin Lumber Co., of Little Rock, Ark., has brought suit in chancery court for $2,000 damages against the Cochran-Foster Lumber Co. and the Southwestern Telegraph & Telephone Co. It also asks that the telephone company be enjoined from using its directory issued last September and be required to issue another directory, immediately.

The complaint alleges that the Cochran-Foster Lumber Co. induced the telephone company to print, in the part of the directory headed "N" the following words immediately following the name and correct telephone number of the Nowlin Lumber Co.: "Nowlin Lumber Co. (See Cochran-Foster Lumber Co. for number.)" These words also occur beneath the name of the Nowlin Lumber Co. in the classified business directory in the back of the book. The plaintiff says that the public has been led to believe the two lumber companies have been merged under one management and that, in consequence, the Nowlin Lumber Co. has lost trade that it otherwise would have secured.

S. A. Cochran, of the Cochran-Foster Lumber Co., stated that he was in business with Mr. Nowlin until three years ago, and that the caption was inserted in the directory in order to remind the public that he had become connected with another company. E. C. Nowlin, of the Nowlin Lumber Co., said that he saw no reason why another concern should continue to use his name after he had withdrawn from the firm. He said that he had intended filing an injunction suit against the telephone company before the new directory was published, but withdrew the suit on the telephone company's promise not to print the objectionable matter in the directory.

Seeks to Restrain Referendum on Buffalo Merger.

In special term of the supreme court at Buffalo, N. Y., last week, Justice Cole heard arguments on the application of Moses C. Mills, a taxpayer, for the continuance of the temporary injunction restraining City Clerk Sweeney from taking necessary action to have referendum questions concerning the proposed merger of the plants of the Federal and New York telephone companies and the starting of a municipal electric light plant placed on the voting machines at the coming general election.

Franchise Provisions Subject to Change to Meet Progress.

"When franchises are granted to public utility corporations by public officials, their provisions must be regarded as subject to change to meet progress," declared Federal Judge Sater, of Columbus, Ohio, in rendering a decision last week in favor of the commissioners of Belmont county. They had brought suit against an interurban railroad in the county which had refused to change the paving between its tracks to correspond with that of a new pike on the right of way. Judge Sater ordered the company, the Wheeling Traction Co., to lay the new paving. His decision is regarded as one of importance to every community in the state which might face a similar situation.

Damages for Use of Land Without Permission.

More than $5 a pole a year was the rental value set by a jury October 5 at Ballsten Springs, N. Y., in an action against the New York Telephone Co., brought by Lucy A. Town to recover for the use of her land in the town of Greenfield. Seven years ago the company constructed a line past the premises of the plaintiff, and nine poles were set along the property line, inside the walk. No permission was received, and objection was made to the location of the poles. The jury awarded the plaintiff a verdict of $300 for six years.

Summary of State Commission Hearings and Rulings.

CALIFORNIA.

October 2: Application filed by the Sunset Telephone & Telegraph Co. for permission to sell its property in Los Angeles county to the Pacific Telephone & Telegraph Co. The Sunset company has not operated any of its property in years but has leased it to the Pacific company.

October 7: Order issued authorizing the Huntington Beach Telephone Co. to charge 25 cents a month in addition to its present rates for desk telephones. The company operates a telephone sytem at Huntington Beach, and has had a rule that those patrons who pay their monthly bills for local exchange service on or before the 10th of the month, shall be allowed a discount of 25 cents. The company also has been charging 25 cents a month for the use of portable or desk telephones in addition to the rate for wall telephones. The company informed the commission that in filing its rate schedule, it failed to file this additional rate. It says that it is now operating its telephone business at a loss, and sought to abolish the monthly discount and to re-establish the additional desk telephone charge. The commission refused to grant the permission to discontinue the discount until after a thorough investigation.

October 16: Hearing held in the Union League building, Los Angeles, on the application of the Southern California Telephone Co. for permission to take over and merge into one the properties of the Pacific Telephone & Telegraph Co. and the Home Telephone & Telegraph Co., in Los Angeles.

ILLINOIS.

October: The commission granted permission to the Mississippi Valley Telephone Co. to increase its rates in Hamilton and the surrounding territory.

October 17: Hearing at Springfield on the investigation, at the commission's own motion as to why physical connection should not be made between the Lebanon Telephone Exchange and the Southwestern Telegraph & Telephone Co. at Lebanon, Ill. Case 5,310.

October 17: Hearing at Springfield in the matter of the application of the Benson (Ill.) Telephone Co., for authority to reissue its promissory note in the amount of $1,400.

KANSAS.

October 13: Hearing on application of the Kansas Telephone Co., of Ottawa, Kan., for permission to purchase and consolidate the two telephone plants at Lawrence, Kan., and the application of the Lawrence Home Telephone Co. and the Missouri & Kansas Telephone Co. for permission to sell their plants and systems at Lawrence to the Kansas Telephone Co. The Bell company at Lawrence has 3,300 telephones and an annual revenue of $47,000, while the Home company has 1,470 telephones and an annual revenue of $22,000. The present value of the Bell plant is given as $293,839 and the Home company as $157,307.

MICHIGAN.

October: The commission approved the plan of the Citizens Telephone Co., of Grand Rapids, Mich., to authorize a general mortgage of $3,000,000 as a basis for an issue of 20-year, 5 per cent. bonds to the same amount. Of the authorized bond issue $600,000 will be offered to investors at par on December 1, 1916, for the purpose of refunding the company's

MINNESOTA.

October 17: Hearing at Bluffton in the matter of the an-

plication of the New York Mills Telephone Co. for an indeterminate permit to construct telephone lines for the purpose of giving local service in the village of Bluffton from its New York Mills exchange.

October 23: Upon the petition of the counsel for the city and switching companies, the hearing upon the application of the Standard Telephone Co. to increase its rates at Preston, Minn., held on October 4, was adjourned to this date.

October 25: The hearing on the application of the Standard Telephone Co. to increase certain of its rates at Caledonia, Minn., which was to have been held at Caledonia on October 5, was adjourned to this date, upon the petition of the counsel for the local subscribers and switching companies.

MISSOURI.

October 14: In the case of the Texas Prairie Telephone Co. and the Star Telephone Co. vs. the Oak Grove Home Telephone Co., of Oak Grove, Mo., the commission ordered the Oak Grove company to file a new rate schedule, effective November 1, making a switching rate of 50 cents a month for each subscriber of the plaintiffs which is to include switching service to Buckner, Napoleon and Lone Jack. The Texas Prairie Telephone Co. and the Star Telephone Co. are two small unincorporated rural telephone companies having 36 telephones on three lines that were previously connected with the board of the Oak Grove Home Telephone Co. and paying the Oak Grove company for switching service. During the year 1915, the Oak Grove company raised the switching rate to 50 cents a month per station and also put into effect a rate of 50 cents a month per subscriber for service to Buckner, Napoleon and Lone Jack, three small villages within a radius of eight miles of Oak Grove. The rural telephone companies thereupon disconnected their lines from the Oak Grove company's switchboard and filed a formal complaint with the commission, alleging that the rates were unreasonable.

NEW YORK.

October 6: At a hearing in Buffalo on the complaint of C. A. Collins relative to the alleged refusal of the Federal Telephone & Telegraph Co. to install telephone service or to refund money paid for a moving charge, it developed that the complaint was due to a misunderstanding of the company's period of service. The case was adjusted to the satisfaction of both parties and dismissed by the commission.

October 16: Hearing at Albany on the complaint of Miss Evanetta Hare, of Troy, N. Y., against the New York Telephone Co. as to discontinuance of service.

OHIO.

October 11: Petition filed by the Ohio State Telephone Co. for permission to put into effect in Cleveland, Ohio, a measured service schedule of rates. According to the proposed schedule, measured service will be offered on one, two and four-party lines, both to business and residence subscribers. Individual line service, measured, will be $2 a month cheaper than the present rate, limited to 100 calls. Four-party service will be reduced 50 cents, limited to 50 calls.

October 14: The commission authorized the Black River Telephone Co., of Lorain, Ohio, to issue its common capital stock of the total par value of $100,000 and its preferred capital stock of the total par value of $200,000. Of the proceeds $100,000 is to be used in the payment and discharge of the company's first mortgage bonds maturing July 1, 1917, $38,786 is to be used to reimburse the company's treasury for moneys expended from income, while the remainder is to be used in erecting a new exchange building, a sub-exchange and a building to be used for storage purposes and in making other improvements incidental to the installation of automatic equipment. Case 951.

October 17: The Millersburg, Wooster & Orrville Telephone Co., a corporation organized under the laws of West Virginia, was authorized by the commission to sell and convey to the Millersburg, Wooster & Orrville Telephone Co., a corporation organized under the laws of Ohio, all of its property and assets at Millersburg, Ohio, and vicinity. Order 929.

October 17: The commission authorized the Millersburg, Wooster & Orrville Telephone Co., of Millersburg, Ohio, to issue its common capital stock of the total par value of $364,-100 and its promissory notes of the total principal sum of $43,500. The proceeds arising from the sale of $25,000 par value of the capital stock is to be used as working capital; $339.100 par value is to be exchanged, at par, for the outstanding capital stock of the Millersburg, Wooster & Orrville Telephone Co., a West Virginia corporation. The proceeds arising from the sale of the notes are to be used to pay and discharge the West Virginia corporation's bonded indebtedness of the principal sum of $38,500 and its outstand promissory notes of the principal sum of $5.000. The commission also rescinded its order of January 15. 1915 (No. 384) insofar as it authorizes the issuance and disposition by the Millersburg, Wooster & Orrville Telephone Co. of $29,400 capital stock. Order 930.

October 17: The commission authorized the Millersburg, Wooster & Orrville Telephone Co., of Millersburg, Ohio, to issue its common capital stock of the total par value of $105,-700, the proceeds to be used for improvements and betterments, and to pay outstanding notes of $43,500. Order 931.

OREGON.

October 16: Hearing in Portland on an application for a physical connection of the systems of the Home Telephone & Telegraph Co., of Portland, and the Pacific Telephone & Telegraph Co.

October 20: Hearing at Tillamook, Ore., on an application for a physical connection between the systems of the Tillamook County Mutual Telephone Co. and the Pacific Telephone & Telegraph Co.

PENNSYLVANIA.

October 5: The commission decided to hear the application of the Keystone Telephone Co. of Philadelphia for a re-opening of its application for the approval of its contract relative to the leasing of space in its conduits to the Philadelphia Electric Co. either November 9 or 10.

WASHINGTON.

October 4: Complaint filed by Mayor A. V. Fawcett against the telephone rates charged by the Pacific Telephone & Telegraph Co. in the city of Tacoma. Particular attention is directed to the rates at pay stations which, it is alleged, are too high.

WISCONSIN.

October 12: Upon the appeal of the Ashland Home Telephone Co. from an ordinance of the common council of Mellen, requiring it to remove its poles from two main streets in Mellen, the commission ruled that such ordinances are proper unless they interfere unreasonably with the ability of a utility to render adequate service or impose a burden not consistent with the benefits to be derived from the improvements.

October 13: The commission denied the Elroy (Wis.) Telephone Co. authority to place another line charge on incoming toll messages or to establish a service charge on a flat-rate basis for the privilege of such connections. The company is also to reconstruct and rebuild outgoing lines and to reduce the number on each line to conform with the standards of the commission.

October 14: Complaint filed by J. H. Keith, president of the Oshkosh Normal School, against the Wisconsin Telephone Co. relative to disconnection of circuits on long distance calls.

October 14: Wheeler Telephone Co. authorized to make proposed extension in the town of Hay Ruver, Dunn county.

October 14: The Price County Telephone Co. filed a rate of $1.55 a month for single line desk telephones equipped with automaphones.

October 14: The City Telephone Co., Turtle Lake, Wis., filed a rate of an additional 15 cents a month on all subscribers' bills whose rentals are unpaid by the 15th of the month in which they are due.

October 11: The commission dismissed the application of the Shaw Telephone Co. for authority to increase rates. The company operates in Eau Claire county and has a central office at Cleghorn. It asked for an increase of 25 cents a month per telephone and for authority to put into effect a 15-cent toll charge for messages from Eau Claire to Cleghorn.

The case is an outgrowth of a previous decision of the commission ordering the company to construct a toll line between Eau Claire and Cleghorn. In dismissing the application the commission substitutes therefor an arrangement whereby the Shaw company and the Wisconsin Telephone Co. are authorized to discontinue the present unlimited service between Cleghorn and Eau Claire and substitute therefor a toll charge of five cents for each three-minute message on a two-number basis and 10 cents for each three-minute message on a particular party basis. The revenues from this arrangement will be apportioned as follows:

The Shaw Telephone Co. shall pay to the Wisconsin Telephone Co. three cents for each message originating at the Cleghorn exchange and terminating at the Eau Claire exchange and the Wisconsin Telephone Co. shall pay to the Shaw Telephone Co. all in excess of three cents per message on messages originating at the Eau Claire exchange and terminating at the Cleghorn exchange.

October 17: Hearing at Madison in regard to the application of the Rock County Telephone Co., of Janesville, for authority to increase its rates for business telephones, both private and two-party. The charge asked for is $3 per month for a single line business telephone, the present charge being $2.50, and of $2.50 a month for a two-party line business telephone, either wall or desk set, the present charge being $2 for a wall set.

Long Distance Transmission of Telephone Currents

Cause of Attenuation of Electrical Waves Transmitted Over Telephone Wires and Mathematical Developments of Theory of Transmission Lines—Early Study of the Subject—The Theory of Loading Telephone Lines—Formulae for Distortion and Losses in Apparatus

By F. B. Dunn

This paper is devoted to the transmission of telephonic current through a pair of long conductors and the sending and receiving apparatus. In general, when the line is short, as in the case of local communication, the problem is simple, for the quality of the line can be improved very easily whenever it is found necessary. However, this is not so on long distance lines, as the electrical waves on the receiving end become so much attenuated that speech is often indistinct or unrecognizable. The cause of this attenuation and the mathematical development of the theory of transmission lines will be discussed in what follows.

Early State of Development.

It was early discovered that both resistance and capacity were hindrances to long distance telephonic transmission, and that aerial lines were better than lines arranged as cables, and copper conductors better than iron. It was also generally believed that inductance was an undesirable element to overcome in transmission line design. In England the "old school" electricians were taught with the empirical rule commonly known as the "K P" law which asserted that the product of capacity and resistance per mile of the telephone cable must not exceed a certain value. This rule was later found without scientific value and declared untrue.

In 1887, Sir Oliver Heaviside, the English physicist, presented the first correct fundamental theory in a paper on "Electromagnetic Induction and Its Propagation," published in The Electrician, London (Vol. XIX, page 79). This was followed later by several other papers, throwing much light upon the subject. Professor Thompson was one of the pioneers who devoted attention to the same subject and a patent, numbered 22,304, was issued to him by the British Patent Office clearly stating that the effects of distributed capacity could be balanced by inductance or leakage.

In 1899 and 1900 Professor M. I. Pupin, of Columbia University, however, cleared the much-discussed subject and successfully reached fruitful results. These results are given in his papers "Propagation of Long Electrical Waves" (Trans. A. I. E. E., Vol. XVI, pages 93-142) and "Wave Transmission Over Non-Uniform Cables and Long Distance Air Lines" (Trans. A. I. E. E., Vol. XVII, pages 445-513).

Electrical Waves in Telephony.

The length of electrical waves varies from a small fraction of a mile to hundreds of miles. The waves with short-wave lengths are those transmitted from the antenna in radio telegraphy and are known as Hertzian waves. Those with long-wave length are found in telephone conductors, especially on long distance transmission.

Suppose an alternating electromotive force is impressed upon a pair of long conductors having considerable amount of mutual capacity, a change in potential and therefore of current at one end will not immediately affect the other end, but the change travels along the conductors as waves. It requires time for the waves to travel from the sending end of the line to the receiving end.

If the impressed electromotive force is so high that one complete cycle would have passed at the sending end before the receiving end begins to note the effect, such a line is said to be over one wave length long. Telephone lines sometimes may be several wave lengths long, depending upon the length of wave and distance of sending and receiving stations. In such cases, the energy supplied to the line is stored up in it in the form of charges traveling toward the receiving end. As the wave travels along, it undergoes changes in form and behaves peculiarly, as will be seen later.

Attenuation.

The charges referred to are nothing but electromagnetic waves. They are subject to decrease in amplitude known as attenuation. Due to the sensitiveness of the human ear, the guessing power of the listener, and the high degree of perfection in the construction of a receiver, the waves may suffer a large amount of attenuation before the human ear will fail to understand the words spoken to the transmitter.

The ratio of the amplitude of a single cycle of alternating current at the receiving end to that of the same cycle at the sending end is known as the attenuation coefficient. Attenuation coefficients with values from 0.05 to 0.01, may be expected to give satisfactory service. Below that conversation is difficult.

Reflection of Waves.

When the electromagnetic waves reach the end of the line, they cannot go farther but are, at least in part, reflected. If the circuit is open, the waves pile up for a moment and then are reflected back. This forms two sets on the line traveling in opposite directions.

If the circuit is closed, a part of the wave will be reflected back and part of it transmitted, as will be seen later. The presence of this state of affairs results in loss of energy known as reflection loss. Space is lacking to treat the reflections in detail.

Propagation of Waves Along Lines.

The most important factors to be considered in designing transmission lines are the capacity, insulation, resistance, inductance and conductance. Supposing the current and voltage are both sine functions of the time, then $i=I\sin 2\pi ft$ and $v=V(\sin 2\pi ft+\theta)$, where θ is the angle of lead, t the time and f the frequency. Putting $p=2\pi f$ and differentiating with respect to time, then

$$\frac{di}{dt}=pI\cos pt,$$

and

$$\frac{dv}{dt}=V\cos(pt+\theta).$$

From the equations it is seen that it is possible to represent these relations by the vectors, which compose the complex quantity, representing the values of maximum current or voltage with a vector whose rotation gives by its projection on any fixed line the instantaneous values. Using this method it is found

$$\frac{dv}{ds}=(R+j\phi L)I \qquad (1)$$

$$\frac{dI}{ds}=(S+jpC)V \qquad (2)$$

where V is maximum voltage, I the maximum current, R the electrical resistance of copper conductor, S the insulation conductance in mhos or the reciprocal of the insulation resistance, C the capacity in farads, L the inductance in henrys per unit length and s the distance from the sending end. The value of p is as above equal to $2\pi f$.

The vector sum of the right-hand member of equation (1) represents the maximum value of $\frac{dV}{ds}$ and that of equation (2) the maximum value of $\frac{dI}{ds}$. Differentiating equations (1) and (2) with respect to distance, s, and substituting,

$$\frac{dv}{ds}=(R+jpL)(S+jpC)V \quad \ldots\ldots(3)$$

$$\frac{dI}{ds}=(R+jpL)(S+jpC)I \quad \ldots\ldots(4)$$

Putting $\mu=\sqrt{(R+jpL)}\sqrt{(S+jpC)}$ and since μ is a complex quantity denoting it by $\alpha+j\beta$, we get by squaring μ.

$$\mu^2=(\alpha+j\beta)^2=\alpha^2-\beta^2+2j\alpha\beta$$

$$\alpha^2-\beta^2+2j\alpha\beta=(R+jpL)(S+jpC)$$

Equating reals and imaginaries,

$$\left.\begin{aligned}\alpha^2+\beta^2&=(RS-p^2LC)\\ 2\alpha\beta&=p(CR+LS)\end{aligned}\right\} \quad \ldots\ldots(5)$$

Solving for α and β,

$$\alpha=\sqrt{\tfrac{1}{2}\left[\sqrt{(SR+p^2LC)^2+p^2(LS-CR)^2}+(SR-p^2LC)\right]} \quad (6a)$$

$$\beta=\sqrt{\tfrac{1}{2}\left[\sqrt{(SR+p^2LC)^2+p^2(LS-CR)^2}-(SR-p^2LC)\right]} \quad (6b)$$

Simplifying,

$$\alpha=\sqrt{\tfrac{1}{2}\left[\sqrt{(R^2+p^2L^2)(S^2+p^2C^2)}+(SR-p^2LC)\right]} \quad \ldots\ldots(7a)$$

$$\beta=\sqrt{\tfrac{1}{2}\left[\sqrt{(R^2+p^2L^2)(S^2+p^2C^2)}-(SR-p^2LC)\right]} \quad \ldots\ldots(7b)$$

α is called attenuation constant and β the wave length constant. Equation (7a) is, however, not convenient for calculation because in most cases the quantity

$$\sqrt{(R^2+p^2L^2)(S^2+p^2C^2)}+SR$$

is so nearly equal to p^2LC that a large error may result when taking their difference, unless the decimal places are carried sufficiently far.

The following is the same equation as (7a) but with p taken as 5,000, C in microfarads, L in millihenrys, R the copper resistance in ohms, r the insulation resistance in ohms, all per unit length, as per mile or per kilometer. If LS=CR, equations (6a) and (6b), reduce to $\alpha=SR$ and $\beta=p\sqrt{LC}$ respectively.

$$\alpha=\frac{\sqrt{C}}{20}\sqrt{\sqrt{R^2+(5L)^2}-5L+\frac{200R}{rC}+0.000128\sqrt{R^2+(5L)^2}}$$

A cable with attenuation and wave length constants like these is called a distortionless cable because the attenuation factor is the same for all frequencies. If the insulation conductance S and the inductance L are both equal to zero, equations (7a) and (7b) become

$$\alpha=\beta=\sqrt{\frac{PCR}{2}} \quad \ldots\ldots(9)$$

From equation (9) it is seen that α and β are both functions of p and therefore of frequency. It is for this reason that the rate of attenuation is more marked on high frequencies than on low. The attenuation factor may be only 0.05 at 800 cycles per second but it would be 0.01 or even less at 2,000 cycles per second. This disproportion of attenuation over a line is called electrical distortion so as to distinguish it from electromechanical distortion existing in the terminal apparatus.

The effect of electrical distortion substantially alters the acoustic character of the sound waves as repeated in the receiver, and changes the quality of the voice. When the frequency is high, the value of the attenuation constant α is great, consequently the attentuation factor is small thus causing the wave velocity, which is $W=p/B$, high. In order to keep the attenuation small and wave velocity low, it is necessary to keep the attenuation constant small. This is very important and can only be attained by keeping the frequency low.

It has been noted that when CR=LS, equation (6) reduces to $\alpha=SR$ and $\beta=p\sqrt{CL}$ and therefore the wave velocity $W=p/\beta=1/\sqrt{CL}$. Thus α and W are both independent of frequency.

Since the product of capacity and resistance is usually greater than that of inductance and conductance in nearly all cables, it will be necessary to make either capacity and resistance small or inductance and conductance large to have the cable nearly distortionless. To this end the following remedies may be devised:

(1) The resistance may be lowered by using larger conductors.

(2) The capacity may be lowered by increasing the space between the cable conductors.

(3) The conductance may be increased by using inferior insulation.

(4) The inductance of the cable may be increased by adding inductance coils to it.

The limit of reducing resistance is soon reached before any significant benefit may be obtained, due to the cost of heavy conductors. It is impracticable.

The capacity of cable may be reduced considerably by using stale manila paper insulation and a dry core. Such a cable has the conductors insulated by a spiral of manila paper which gives a certain amount of air space between the conductors. This reduction of capacity, however, is not sufficient to balance the inductance and conductance.

Loading of Cable.

It is impracticable to increase the conductance because the conductance in ordinary cables is extremely small and an increase involves too low an insulation resistance. If the inductance is also a small quantity, it is evident that it is not practicable to increase it to any great extent. It is, however, possible to increase the total inductance by connecting inductance coils in series with the line.

This device was tried out first in England with a total failure, due to the fact that the inductance coils were distributed on the line at great distances apart, while the mathematical results were obtained by assuming that the inductance was uniformly distributed over the line. The widely-separated coils therefore did not reproduce the conditions assumed.

When the electromagnetic wave reaches the point where a change of impedance occurs, it is partly transmitted with diminished amplitude and partly reflected back. Now if there are a number of such obstacles on its path, as in the case of concentrated inductances on the line, the amplitude of the wave would be decreased on passing each inductance coil so that the total attenuation is greatly increased. These coils, spaced a great distance apart, thus did harm rather than good. On the other hand, if the coils are distributed at small distances compared with the wave length, they will act nearly like a uniform inductance and balance the capacity and resistance.

This was pointed out by Professor M. I. Pupin in the paper previously mentioned. He found that at least nine or ten such coils should be distributed along each wave length.

Cohen's Formula for Transmission Line Calculation.

Applicable formulae, taking sending and receiving apparatus into consideration for transmission line calculations, were developed by the governmental physicist L. Cohen, Washington, D. C. His expressions were, of course, based on Professor Pupin's theory.

In his collected papers, volume II, page 245, Dr. O. Heaviside treated the subject under the heading "The effect of a periodic impressed force acting at one end of a telegraphic circuit with any terminal condition." The work was elaborately carried out and the mathematical expressions are very complicated. Cohen's treatment reached final results, which are comparatively simple and calculable. A survey of Cohen's procedure in reaching his results is herein given.

Since, as previously noted, the insulation conductance of nearly all cables is negligible, it will be profitable to assume it to be zero at the outset, thus leaving out all terms containing S.

Let L, R, and C denote the inductance, resistance, and capacity per unit length of outgoing and return; also, let L_o, R_o, C_o, and L_1, R_1, C_1, represent the inductance, resistance and capacity of the sending and receiving apparatus respectively. Let i and v denote the current and voltage at any point on the line and s the distance from the sending end which will be taken as origin. Now the electromotive force expended in overcoming the ohmic resistance and inductance and the current in charging the line may be represented mathematically as follows:

$$L\frac{di}{dt}+Ri=-\frac{dv}{ds} \quad \ldots\ldots (10)$$

$$C\frac{dv}{dt}=-\frac{di}{ds} \quad \ldots\ldots (11)$$

Differentiating equation (10) with respect to t and equation (11) with respect to s,

$$L\frac{d^2i}{dt^2}+R\frac{di}{dt}=-\frac{d^2v}{dsdt} \quad \ldots\ldots (12)$$

$$L\frac{d^2v}{dtds}=-\frac{1}{C}\frac{d^2i}{ds^2} \quad \ldots\ldots (13)$$

From equations (12) and (13),

$$L\frac{d^2i}{dt^2}+R\frac{di}{dt}=\frac{1}{C}\frac{d^2i}{ds^2} \quad \ldots\ldots (14)$$

Equation (14) is the differential equation of propagation of an electrical wave along the cable. Assume the current to be simple harmonic with respect to time then,

$$i=Ie^{jpt} \quad \ldots\ldots (15)$$

where I is the maximum current.

Now differentiate equation (15) twice, first with respect to s and then with respect to t. Remember t and s are independent to each other and I is independent to t. Carrying out the operation, it is found,

$$\frac{di}{ds}=\frac{dI}{ds}e^{jpt}$$

$$\frac{d^2i}{ds^2}=\frac{d^2I}{ds^2}e^{jtp} \quad \ldots\ldots (16)$$

$$\frac{di}{dt}=Ijpe^{jpt}$$

$$\frac{d^2i}{dt^2}=-Lp^2e^{jpt} \quad \ldots\ldots (17)$$

From equations (14), (16), and (17),

$$(-CLp^2+jCRp)I=\frac{d^2I}{ds^2} \quad \ldots\ldots (18)$$

To find the complete integral of equation (18) let

$$-\mu^2=(-CLp^2+jCRp) \quad \ldots\ldots (19)$$

Therefore,

$$\frac{d^2I}{ds^2}+\mu^2I=o$$

The complete integral of the above differential equation is

$$I=A\sin\mu s+B\cos\mu s \quad \ldots\ldots (20)$$

From equation (15), $i=(A\sin\mu s+B\cos\mu s)e^{jpt}$ ..... (21)

Therefore the current at the receiving end of the line whose length is l, whose $s=l$

$$i_l=(A\sin\mu l+B\cos\mu l)e^{jpt}$$

Now since $-\mu^2$ is a complex quantity, μ is evidently also a complex quantity and it may be written, $\mu=j(\alpha-j\beta)=\beta+j\alpha$.

From equation (19), $-(\beta+j\alpha)^2=-CLp^2+jCRp$ ..... (23)

Equating reals and imaginaries in equation (23) separately,

$$-\alpha^2+\beta^2=CLp^2$$

$$-2\alpha\beta=CRp$$

Solving for α and β,

$$\left.\begin{aligned}\alpha&=\sqrt{\tfrac{1}{2}Cp\ (\sqrt{L^2p^2+R^2}-Lp)}\\ \beta&=\sqrt{\tfrac{1}{2}Cp\ (\sqrt{L^2p^2+R^2}+Lp)}\end{aligned}\right\} \quad \ldots\ldots (24)$$

Equation (24) is identical with equations (7a) and (7b) when S is zero.

The next step will be to find the electromotive force at any point on the line.

Differentiating equation (21) with respect to s,

$$\frac{di}{ds}=\mu(A\cos\mu s-B\sin\mu s)e^{jpt} \quad \ldots\ldots (25)$$

From equations (11) and (25),

$$v=\frac{\mu}{C}\int(B\sin\mu s-A\cos\mu s)e^{jpt}dt$$

Integrating

$$v=\frac{\mu}{jCp}(B\sin\mu s-A\cos\mu s)e^{jpt} \quad \ldots\ldots (26)$$

Equation (26) expresses the electromotive force at any point, therefore at the receiving end where $s=l$, we have

$$v_l=\frac{\mu}{jCp}\left\{B\sin\mu l-A\cos\mu l\right\}e^{jpt} \quad \ldots\ldots (26a)$$

In order to find the values of A and B in equation (20), it will be necessary to consider the electromotive force at both sending and receiving ends, that is, the values of v when $s=l$. Now the electromotive force at the receiving end is equal to the drop in the receiving apparatus impedance. This drop is

$$v_l=i_l\left\{R_l+(PL_l-\frac{1}{C_lp})\right\} \quad \ldots\ldots (27)$$

which is the value of v_l represented vectorially.

From equation (26)

$$v_l=\frac{\mu}{jCp}(B\sin\mu l-A\cos\mu l)e^{jpt} \quad \ldots\ldots (28)$$

Equating equations (27) and (28) and substituting the value of i in (27) by that obtained in equation (22),

$$\frac{\mu}{jCp}(B\sin\mu l-A\cos\mu l)=$$

$$\left\{R_l+j(L_lp-\frac{1}{C_lp})\right\}(A\sin\mu l+B\cos\mu l) \quad (B\sin\mu l-A\cos\mu l)$$

$$=\frac{jCp}{\mu}[R_l+j(L_lp-\frac{1}{C_lp})]\cdot\ (A\sin\mu l+B\cos\mu l) \quad \ldots\ldots (29)$$

Let

$$H_1+jF_1=\frac{jCp}{\mu}[R_l+j(L_lp-\frac{1}{C_lp})]$$

Remembering $\mu=\beta+j\alpha$

$$H_1+jF_1=\frac{jCp}{\beta-j\alpha}[R_l+j(L_lp-\frac{1}{C_lp})]$$

Simplifying,

$$H_1+jF_1=\frac{jCp(\beta-j\alpha)}{\alpha^2+\beta^2}[R_l+j(L_lp-\frac{1}{C_lp})]$$

Equating the reals and imaginaries separately,

$$\left.\begin{aligned}H_1&=\frac{Cp}{\alpha^2+\beta^2}[\alpha R_l-\beta(L_lp-\frac{1}{C_lp})]\\ F_1&=\frac{Cp}{\alpha^2+\beta^2}[\beta R_l+\alpha(L_lp-\frac{1}{C_lp})]\end{aligned}\right\} \quad \ldots\ldots (30)$$

Equation (29) may be written,

$$(B\sin\mu l-A\cos\mu l)=(H_1+jF_1)(A\sin\mu l+B\cos\mu l) \quad \ldots\ldots (31)$$

When $s=0$, the value of electromotive force is the impressed E. M. F. minus the drop due to the sending apparatus or,

$$v_o=Ee^{jpt}-i_o[R_o+j(L_op-\frac{1}{C_op})] \quad \ldots\ldots (32)$$

Where E is maximum electromotive force.

When $s=o$ equation (26) becomes,

$$v_o=(-\frac{\mu}{jCp})Ae^{jpt} \quad \ldots\ldots (33)$$

and equation (32) becomes,

$$v_0 = Ee^{jpt} - Be^{jpt}[R_0 + j(L_0p - \frac{1}{C_0p})] \quad \text{.....(34)}$$

When $s=0$, equation (21) reduces to,

$$i_0 = Be^{jpt}.$$

Equating the values of v_0 in equations (33) and (34),

$$\frac{-\mu A}{jCp} = E - B[R_0 + j(L_0p - \frac{1}{C_0p})] \quad \text{.....(35)}$$

Simplifying,

$$\frac{jECp}{\mu} = \frac{jCpB}{\mu}[R_0 + j(L_0p - \frac{1}{C_0p})] - A \quad \text{.....(36)}$$

Let

$$T_1 + jT_2 = \frac{jCp}{\mu}[R_0 + j(L_0p - \frac{1}{C_0p})]$$

Since it is a complex quantity, by the same method as the values of H_1 and F_1 were found, the values of T_1 and T_2 are found

$$T_1 = \frac{Cp}{\alpha^2 + \beta^2}[\alpha R_0 - \beta(L_0p - \frac{1}{C_0p})] \quad \text{.....(37a)}$$

$$T_2 = \frac{Cp}{\alpha^2 + \beta^2}[\beta R_0 + \alpha(L_0p - \frac{1}{C_0p})] \quad \text{.....(37b)}$$

Equation (36) may be written,

$$E\frac{jCp}{\mu} = (T_1 + jT_2)B - A \quad \text{.....(38)}$$

From equation (38),

$$B = \frac{E\frac{jpC}{\mu} + A}{T_1 + jT_2}$$

substitute this value of B into equation (31) and solve for A,

$$A = \frac{jECp}{\mu}\left\{\frac{\sin\mu l - (H_1 + jF_1)\cos\mu l}{(T_1 + jT_2)(H_1 + jF_1)\sin\mu l + \cos\mu l] - [\sin\mu l - (H_1 + jF_1)\cos\mu l]}\right\} \quad \text{.....(39a)}$$

Similarly the value of B is found to be:

$$B = \frac{jECp}{\mu}\left\{\frac{\cos\mu l + (H_1 + jF_1)\sin\mu l}{(T_1 + jT_2)(H_1 + jF_1)\sin\mu l + \cos\mu l] - [\sin\mu l - (H_1 + jF_1)\cos\mu l]}\right\} \quad \text{.....(39b)}$$

Substituting the values of A and B in equations (21) and (26),

$$i = \frac{jECpe^{jpt}}{\mu}\left\{\frac{\cos\mu(l-s) + (H_1 + jF_1)\sin\mu(l-s)}{(T_1 + jT_2)(H_1 + jF_1)\sin\mu l + \cos\mu l] - [\sin\mu l - (H_1 + jF_1)\cos\mu l]}\right\} \quad \text{.....(40)}$$

$$v = \frac{E\mu\{(H_1 + jF_1)\cos\mu(l-s) - \sin\mu(l-s)\}e^{jpt}}{\mu(T_1 + jT_2)(H_1 + jF_1)\sin\mu l + \cos\mu l] - \mu[\sin\mu l - (H_1 + jF_1)\cos\mu l]} \quad \text{.....(41)}$$

Remembering $\mu = \beta + j\alpha$ and $\sin j\alpha l = \frac{\epsilon^{j\alpha l} - \epsilon^{-j\alpha l}}{2j}$, $\cos j\alpha l = \frac{\epsilon^{j\alpha l} + \epsilon^{-j\alpha l}}{2j}$

So that sin μl and cos μl may be written:

$$\sin\mu l = \frac{1}{2}\left\{\sin\beta l(\epsilon^{\alpha l} + \epsilon^{-\alpha l}) + \frac{j}{2}\cos\beta l(\epsilon^{\alpha l} - \epsilon^{-\alpha l})\right\} \quad \text{.....(42a)}$$

$$\cos\mu l = \frac{1}{2}\left\{\cos\beta l(\epsilon^{\alpha l} + \epsilon^{-\alpha l}) - \frac{j}{2}\sin\beta l(\epsilon^{\alpha l} - \epsilon^{-\alpha l})\right\} \quad \text{.....(42b)}$$

Substitute the values of sin μl and cos μl in the denominators of equations (40) and (41), and equating it to $K_1 + jK_2$,

$$K_1 + jK_2 = \mu[(T_1 + jT_2)\{(H_1 + jF_1)[\frac{1}{2}\sin\beta l(\epsilon^{\alpha l} + \epsilon^{-\alpha l}) + \frac{j}{2}\cos\beta l(\epsilon^{\alpha l} - \epsilon^{-\alpha l})] + [\frac{1}{2}\cos\beta l(\epsilon^{\alpha l} + \epsilon^{-\alpha l}) - \frac{j}{2}\sin\beta l(\epsilon^{\alpha l} - \epsilon^{-\alpha l})]\}$$
$$- \mu[\frac{1}{2}\sin\beta l(\epsilon^{\alpha l} - \epsilon^{-\alpha l}) + \frac{j}{2}\cos\beta l(\epsilon^{\alpha l} + \epsilon^{-\alpha l})] - (H_1 + jF_1)[\frac{1}{2}\cos\beta l(\epsilon^{\alpha l} + \epsilon^{-\alpha l}) - \frac{j}{2}\sin\beta l(\epsilon^{\alpha l} - \epsilon^{-\alpha l})]\} \quad \text{.....(43)}$$

Equating reals and imaginaries and remembering

$$\sinh\alpha l = \frac{\epsilon^{\alpha l} - \epsilon^{-\alpha l}}{2} \text{ and } \cosh\alpha l = \frac{\epsilon^{\alpha l} + \epsilon^{-\alpha l}}{2}$$

$$K_1 = \cos h\alpha l(\xi_1\beta\cos\beta l - \xi_1\alpha\cos\beta l - \beta\sin\beta l) + \sinh\alpha l\{-\xi_1\alpha\cos\beta l(L_1p - \frac{1}{C_1p}) - \xi_1 C_1 p\sin\beta l\}$$
$$- \xi_1\alpha(L_1p\frac{1}{C_1p})\sin\beta l + \sinh\alpha l\{C_1 p\sin\beta l - \xi_1 C_1 p\cos\beta l + \xi_2 C_2 p(L_1p - \frac{1}{C_2p})\cos\beta l\}$$
$$+ \sinh\alpha l(\xi_1\alpha\sin\beta l + \xi_1\beta\sin\beta l + \alpha\cos\beta l) \quad \text{.....(44)}$$

$$K_2 = \cos h\alpha l(\xi_1\alpha\cos\beta l + \xi_1\beta\cos\beta l - \alpha\sin\beta l) + \sinh\alpha l\{C_1 p\cos\beta l + \xi_1 C_1 p\sin\beta l\}$$
$$- \xi_1 C_1(L_1p - \frac{1}{C_1p}) + \sinh\alpha l\{C_1(L_1p - \frac{1}{C_1p})\sin\beta l - \xi_1 C_1 p\cos\beta l\} - \xi_1 C_2(L_2p - \frac{1}{C_2p})\cos\beta l$$
$$+ \sinh\alpha l(-\xi_1\beta\sin\beta l + \xi_1\alpha\sin\beta l - \beta\cos\beta l) \quad \text{.....(45)}$$

T_1 and T_2 are transmitting apparatus constants. If these are neglected, equations (44) and (45) are greatly simplified.

Now in the numerators of equations (40) and (41) let ω denote $l-s$, thus sin μ $(l-s)$ becomes sin $\mu\omega$ and cos μ $(l-s)$, cos $\mu\omega$; substitute for sin $\mu\omega$ and cos $\mu\omega$ values similar to equations (42a) and (42b). Making this substitution, putting $K_1 + jK_2$ for the denominators of equations (40) and (41), and simplifying,

$$i = \frac{jECp(\mu^2 + \rho^2)}{\mu^2 + \rho^2}\{\cos\beta\omega\cos h\alpha\omega - j\sin\beta\omega\sin h\alpha\omega + H_1\sin\beta\omega\cos h\alpha\omega + jH_1\cos\beta\omega\sin h\alpha\omega$$
$$+ jF_1\sin\beta\omega\cos h\alpha\omega - F_1\cos\beta\omega\sin h\alpha\omega\}\epsilon^{-jpt} \quad \text{.....(46)}$$

$$v = \frac{\epsilon(\beta + j\alpha)(\mu - j\rho)}{\mu^2 + \rho^2}\{H_1\cos\beta\omega\cos h\alpha\omega - jH_1\sin\beta\omega\sin h\alpha\omega + jF_1\cos\beta\omega\cos h\alpha\omega + F_1\sin\beta\omega\cos h\alpha\omega$$
$$- \sin\beta\omega\cos h\alpha\omega - j\cos\beta\omega\sin h\alpha\omega\}\epsilon^{jpt} \quad \text{.....(47)}$$

Equations (46) and (47) are expressions for current and electromotive force at any point on the line, taking into consideration resistance, inductance, and capacity of the sending and receiving apparatus.

After some further reduction, the final form for the real parts of equations (46) and (47) are:

$$i = \frac{\epsilon Cp}{2\sqrt{\mu^2 + \rho^2}}\left\{\epsilon^{\alpha\omega}\cos(p\omega - \beta\omega + \theta) + \epsilon^{-\alpha\omega}\cos(p\omega + \beta\omega + \theta)\right\} + \sqrt{H_1^2 + F_1^2}\left\{-\epsilon^{\alpha\omega}\cos(p\omega - \beta\omega - \phi + \theta)\right\} + \epsilon^{-\alpha\omega}\cos(p\omega + \beta\omega - \phi + \theta)\} \quad \text{.....(48)}$$

$$v = \frac{\epsilon\sqrt{\mu^2 + \rho^2}}{2\sqrt{\mu^2 + \rho^2}}\left\{\epsilon^{\alpha\omega}\cos(p\omega - \beta\omega + \theta + \delta) + \epsilon^{-\alpha\omega}(p\omega + \beta\omega + \theta + \delta)\right\} + \sqrt{H_1^2 + F_1^2}\left\{\epsilon^{\alpha\omega}\cos(p\omega - \beta\omega - \phi + \theta + \delta) + \epsilon^{-\alpha\omega}\cos(p\omega + \beta\omega - \phi + \theta + \delta)\right\} \quad \text{(49)}$$

where $\tan\theta = \frac{\mu}{\rho}$ $\tan\delta = \frac{\alpha}{\beta}$ $\tan\beta = \frac{\alpha}{\beta}$

The interesting point is that equations (48) and (49) show that there are four distinct waves on the line—the first two sent out by the transmitting apparatus and the second part two reflected waves. When $s=l$ and $\omega=0$, equation (46) may be reduced to

$$i = \frac{\epsilon Cp\cos(pt + \theta)}{\sqrt{\mu^2 + \rho^2}} \quad \text{.....(50)}$$

From equation (50) the maximum values of i may be calculated for different frequencies, first by neglecting the terminal apparatus. From these values the degree of distortion of the apparatus and then by taking into consideration the terminal cable, the losses due to sending and receiving apparatus, and other effects of terminal apparatus may be found.

Public Utility Bonds Recommended as Investment.

At the annual convention of the Investment Bankers' Association, held recently in Cincinnati, Ohio, the public service corporations committee recommended public utility bonds as a means of investment. This recommendation was made as a result of a year's investigation in this field and below are quoted a few extracts from the report of the committee:

"In regard to the kinds of utilities which afford a suitable field for savings bank investment, your committee believes it is advisable, for the present at least, to include only companies furnishing artificial gas, electric light and power, local transportation and telephone and telegraph service to the public.

In regard to telephone companies the committee believes that gross earnings of at least $1,500,000 should be required in order to give the assurance that a company occupies either a large and permanent center of population or else covers a large area so as to include a proper field for long distance communication and give a full service, long distance as well as local.

The committee suggests that investment should be limited to companies located within the United States, and believes that investment can to advantage be further limited to those states only which have public utility commissions with powers of protection of utilities and their investments. It is believed that sufficient protection is afforded where a commission, through control of rates, can assure to a company a fair return on its property investment, honestly and prudently made, and where the laws provide that any new utility must obtain a certificate of public convenience and necessity from the commission before starting in business. Consequently, the committee suggests the further restriction of investment to utilities located in states which give such protection."

Additional State Convention Announcements.

Secretary A. S. Hall, of the South Dakota Independent Telephone Association has announced that the annual convention of the association will be held in Aberdeen on January 16, 17 and 18. These dates were announced in a previous issue but the place at which the convention was to be held, had not at that time been decided upon.

The convention of the Minnesota Independent Telephone Association is to be held on January 23, 24 and 25 at St. Paul and not at Minneapolis, as previously announced.

Fundamental Principles of the Telephone Business

A Reading Course Designed to Present Logically the Principles Which Underlie Successful Organization and Operation of Telephone Properties—Prepared Under the General Supervision of Stanley R. Edwards—Part I, Telephone Economics, by James H. Shoemaker, Completed June 26, 1915—Part II, The Corporate Telephone Organization, by J. C. Kelsey and S. R. Edwards, Completed September 25, 1915—Part III, Telephone Accounting and Auditing, by James H. Shoemaker, Completed January 15, 1916—Part IV, Telephone Finance, by J. C. Kelsey and S. R. Edwards, Completed June 3, 1916—Installments Now Being Presented Comprise Part V, Telephone Advertising and Publicity, Written by Roy D. Mock

Quiz Questions on the Preceding Installment.

91. Discuss the effectiveness of a long distance call for business purposes.

92. What has been a deterring factor to the rapid development of long distance business? State a common fault of many advertisements of long distance service.

The Telephone Assists the Shopper and the Merchant

Everyone likes to know where goods of special quality, in which they are interested, can be obtained.

By calling the attention of his customers by telephone to special values in merchandise, the progressive merchant transforms dull hours into busy hours.

When business is light, he gives his clerks a list of prospective customers with instructions to call them by telephone and tell them of the attractive things in his stock.

By following up this practice systematically much profitable trade is obtained, that would otherwise be lost.

There are no dull hours in the business establishment which develops telephone salesmanship to its highest possibilities.

THE TELEPHONE MAKES EVERYONE YOUR NEIGHBOR

Independent Telephone Co.

OF COUNCIL BLUFFS

FRANK ELGAN, District Manager.

J. A. MADDEN, Local Manager.

Fig. 83. A Double Suggestion Advertisement As to Use.

93. Discuss the advertisements reproduced in Figs. 76, 77 and 78.

94. What idea has been used with profit by the Tri-State Telephone & Telegraph Co. to stimulate long distance business with the traveling public?

95. Among what class is the most extensive use of long distance telephone service found? What is the most profitable way to cultivate it?

96. Outline the results obtained by specificness in an advertisement of long distance service.

97. Discuss the reasons for a general increase in toll business to points not covered by the specific appeal in an advertisement.

CHAPTER VII. New Business Advertising (Concluded).

98. *Arguments in Favor of Promoting More Extensive Use of Telephone.*—Various examples have previously been given of advertisements designed to increase the use of the telephone. For instance, Figs. 42 and 43, TELEPHONY of August 19, are specimens of advertisements intended to suggest new uses for the telephone. Quite obviously where measured service is the rule, every additional telephone call that can be secured as a result of such advertising means so much additional income to the company. That is the reason why telephone companies which sell measured service should advertise specific uses.

The manager of a telephone company which quotes flat rates may sometimes wonder why he should attempt to influence his subscribers to use the telephones more. Looking at the

THEY are all in reach at a moment's notice: the butcher, the grocer, merchant, anyone you wish.

At Your Elbow

This is because the Bell System radiates throughout the country and is universal.

Whether weather conditions are stormy, threatening or fair the Bell Telephone is in waiting to save unnecessary footsteps.

Everybody is your neighbor; every town, county and state is next door.

The Gallia Telephone Co.

Fig. 84. Advertisement Designed to Increase Use of Telephone.

Put Your Best Salesman On The Wire

UNSETTLED conditions should not discourage the efficient sales manager. His problem is to increase sales and reduce selling costs. The *telephone* helps solve the problem. For example:

A large wholesale house recently felt the necessity of reducing the cost of marketing their goods. The Telephone Company suggested **selling by telephone.** It pointed out the fact that the salesmen who secure the best results when they call upon the buyer personally will also secure the best results **over the telephone.** It showed how these expert salesmen could interview at least twenty times as many buyers by **telephone** as they could see in person. A campaign was started early in August. It was at once successful and is being continued this fall with increasing results.

You can fit the *telephone* into *your* sales campaign in such a way that you can increase your sales and reduce your selling expense.

Information will be gladly furnished at our Business office as to the best way to adapt the telephone to your selling campaign.

The Chesapeake and Potomac Telephone Company
OF VIRGINIA

Fig. 85. Argument for Selling Over the Telephone.

matter in a short-sighted way, it might appear that this would indeed be bad business, since the company would have to handle more calls for the same amount of money, which does not seem like good business at all. But viewing the matter in a more broad-minded way, it is easy to see that the more indispensable the telephone becomes to subscribers, the less likelihood there is of their having the service discontinued.

Viewed in this light, it is an actual advantage for a telephone company, no matter how its charges are based, to promote the broader use of the telephone. Also, one of the strongest arguments that can be advanced in the securing of new business is to cite examples of the many purposes for which the telephone can be used.

99. *Newspaper Advertisements Advocating Increased Use of Telephone.*—To a family which has never enjoyed telephone service, a telephone seems rather a vague benefit. The members of the family know it is an instrument that enables them to do their talking without walking, but perhaps the many ways in which a telephone can be used have never occurred to them. Advertising which suggests these uses will therefore have a two-fold effect:

First, it will make present subscribers appreciate more keenly the benefit of the telephone; and second, it will make prospective subscribers feel a more definite need for the telephone. And both of these results are very much worth while.

Dear Madam:
We have been wondering if you fully realize how great a benefit your telephone can be in your home.
We know you use it for social purposes, such as calling up your friends and perhaps arranging for little parties, etc. and perhaps you do some of your shopping over the wire instead of over the counter.
A telephone call to some of your friends or relatives in neighboring towns would be very much appreciated by them. And the cost to you need not run over 15 cents or 20 cents. Surely it is worth that much to give them a little surprise. Simply call the long distance operator.
If you are going out for the evening, use the telephone to call a cab or a taxi. If you want to send a telegram or desire a messenger boy, call up the telegraph office.
To summon the fire department, call No. 10. To summon police assistance, call No. 20.
We are very much interested in having you obtain the fullest possible use from your telephone and are ready at all times to co-operate with you or to receive suggestions.
Yours cordially,

Fig. 86. Suggestion for Form Letter to Residence Subscribers.

Figs. 83 and 84 are both examples of advertisements designed to increase the use of the telephone by suggesting that shopping can be accomplished just as well over the wire as over the counter. Of these two, the advertisement reproduced in Fig. 83 is undoubtedly the stronger because of the additional suggestion it contains that merchants can also make profitable use of the telephone by calling up their customers regarding offerings of merchandise which may be specially attractive.

I am sending you this to let you know that I have had a CITIZENS TELEPHONE installed in my residence at

_____

MY Telephone Number is

_____

_____**191**__

Fig. 87. Post Card for Use of Residence Subscribers Before New Directory Appears.

In Fig. 85, which is a reproduction of a Bell advertisement, is contained an argument that might well be adopted by many Independent companies. The science of selling goods over the telephone is as yet only in its infancy, but it is sure to show rapid development. Independent telephone men have a great field here in educating business men regarding ways to use the telephone advantageously in the selling of goods.

100. *Other Advertising Means to Promote Use of Service.*—Suggested copy for a form letter to be sent out to resident subscribers is given in Fig. 86. Naturally such a letter will have to be worded to fit local conditions. Fig. 86 is simply designed to offer some suggestions.

A handy little post card recently gotten out by the Citizens Telephone Co. which operates in Grand Rapids, Lansing, and a number of other Michigan cities, is reproduced in Fig. 87. These post cards are given to each new subscriber for residence service, the intention being to provide a convenient means whereby he may inform his friends of the fact that he has just had a telephone installed.

Such a card is of considerable service to the new subscriber and his friends. It also has a tendency to cut down the number of information calls from people who want to know whether or not this party has a telephone and if so, what number has been assigned him.

CHAPTER VIII. Advertising to Increase Good Will.

101. *A Definition of Good Will.*—Good will is just beginning to be appreciated as an asset. It is difficult to state definitely in a few words what is meant by good will, but it really is the *desire* on the part of people to do business with a certain company. Please note the presence of that word "desire," and remember that people may be forced to do business with a company without any real desire on their part to do so. The good will of an Independent telephone company is that intangible something which makes people like to do business with that company and gives them a feeling of friendly cordiality toward the company. Consequently, to secure good will is really the purpose of all advertising and selling effort.

A few years ago it was rumored that the owners of the Royal Baking Powder Co. were offered $5,000,000 for the use of the word "Royal" alone as applied to baking powder. For this vast sum of money, the prospective buyers did not expect to receive anything in the way of stock on hand, machinery, factory—in fact, nothing of tangible value. But they were willing to pay a million dollars a letter for the use of that word "Royal." What they wanted to buy was really the good will of the Royal Baking Powder Co.—the desire of people to buy Royal baking powder instead of some other brand.

It is given to but few concerns to have such an offer made them. Yet from the time it starts in business every concern is engaged in the effort to build up good will. The more good will it has, the easier the company will find it to sell its merchandise or service.

102. *Value of Good Will.*—Good will is more valuable than plant equipment because plant equipment is usually insured and when destroyed, can be replaced. But when good will is once destroyed or lost, it is difficult indeed to get back into the good graces of the public.

Telephone companies are operated under franchises of some kind. In case of a franchise from a local body, it is worth a great deal to the company to have the people on its side—particularly when renewal of the franchise comes up for discussion. Whenever the question of readjustment of telephone rates comes up, it is usually worth a great deal of money to the telephone man to have the people of the community in full agreement with the contention of the company.

It is easy to see that this indefinite something which we call good will has indeed an extremely definite value.

(To be Continued.)

Municipally-Owned Utilities Need State Regulation.

That state regulation is needed even more for municipally-owned utilities than for private utilities is the conclusion of C. M. Larson, assistant state chief engineer of the Department of Engineering of Wisconsin, in a paper presented at the convention of the New Jersey Utilities Association, held at Atlantic City last week. "Is seems to be conceded," Mr. Larson stated, "that private utilities should be subjected to state control, but experience shows that municipal plants violate the prescribed rules of service more often than private plants; also that the schedules submitted by municipal utilities are equally as objectionable because of discriminations made in regard to rates."

"If the only function of a regulating body," he went on to say, "was that of limiting the total profits of a utility, there would be little call for the state to step in. However, modern developments in social affairs have forced an entire change until it is now quite generally conceded that the services supplied by the utilities are real public necessities. It necessarily follows that the regulation of the utility must be considered from the point of service first and rates or profits second. It is on the question of the importance of service as compared with rates that the commission often meets opposition from municipally-owned utilities."

Mr. Larson called attention to the fact that while the private utilities have accepted the accounting regulations prescribed by the commission, many municipalities owning plants have entered strenuous protests against complying with these requirements. He contended that without proper accounting systems, it was impossible to determine and apportion costs of service and declared that if there were no commission, municipalities would be unlikely to keep any records of value on plant operation. He pointed out that in 1914 it was found that approximately half of the private water plants in the state and less than 28 per cent of the municipal plants made reports that were considered good.

On the subject of rates, Mr. Larson pointed out that the making of rate schedules is a most difficult matter, requiring experience and ability. He argued that if municipal utilities are allowed to make their own rates it would be a difficult matter for them to get the required experience and ability because of the fact that the management of a municipal plant often changes each time the council changes, and "the municipal plant is too often used as a foot-ball in the political game and unless rules and standards are laid down by an authority from some independent source, the consumers are sure to suffer."

Movement for Municipal Ownership in Spokane.

Considerable agitation has arisen in Spokane, Wash., in favor of municipal ownership and operation of the local telephone properties of the Pacific Telephone & Telegraph Co. At a recent mass meeting a resolution was adopted which provided for the establishment of a municipal telephone plant, the immediate cancellation of the Home telephone franchise under which the Pacific company is now operating and the passage by the next legislature of a home rule measure.

Your Rate Case

Continued from Last Week—Facts Necessary to Determine Value

By J. C. Kelsey

The value of any property is a question of economics. The chances are that the directors of the Brown Telephone Co. had never heard of nor read a book on political economy, but each man had such a knowledge of values that he had been successful in acquiring means above the average.

These men know and act upon the rule of economics, whether they know it or not, that the buyer fixes the price by which property passes from a willing vendor to a willing vendee in a fair transfer, and this establishes the value of the property.

Economic laws are not mysterious. Such laws are simply natural laws of the commercial and living world, developed and tested out by usage of the past, not man-made but man-tried, and not subject to arbitrary control or artificial rules.

The value of a useful property, such as a going telephone concern employed in giving service necessary to and desired by the public, depends upon the extent of its usefulness and the manner in which it can take care of the needs of its customers.

Accordingly, political economists, however theoretical we may assume them to be, have demonstrated that the value of the property of the Brown Telephone Co. depends upon ownership, effort or cost, and utility.

This value must not be confused with the sum of the costs represented by the original investment. Neither must it be limited to what it costs new to reproduce the physical structure. It cannot be expressed in mathematical formulas, and remains only as a matter of judgment, founded upon all the conditions.

It has been expressed in the Minnesota rate case: *"The ascertainment of that value is not controlled by artificial rules. It is not a matter of formulas but there must be a reasonable judgment, having its basis in a proper consideration of all relevant facts."*

What the property originally cost does not necessarily measure its value. In the San Diego Land and T. Co. vs. Jasper, the United States Supreme Court held as follows: *"No doubt cost may be considered, and will have more or less importance according to circumstances."*

The cost of reproducing the property is also not necessarily its value. The Interstate Commerce Commission in the Illinois Central freight rate case, said: *"The cost of reproducing railway property has been suggested as a basis upon which returns should be allowed. But this, while of great assistance in arriving at a just result, could not be taken as an exclusive guide.*

"Moreover, the *value* of a railway system *does not depend upon the mere cost* of its improvements or its equipment. *It is* rather a *question of location, of connections, of terminal facilities, of enterprises* along its line."

"Shall nothing be allowed to the foresight and ability which has marked out and perfected the system?"

The cost of reproduction new, and the other theory of cost of reproducing new, less depreciation, seems to have taken hold of many commissions. But these two factors are only factors of partial value. The valuation act which Congress passed, never for one moment considered these factors alone.

Not only does the cost of construction enter into it, but it specifically demands the amount of money invested, the sources of the money and the cost of financing. In fact, a complete financial history is considered necessary.

It is not an engineering problem at all, except possibly in some physical factors, but rather a combination of problems—legal, social, economic, and political. In other words, it gets back to the story of the race horse being valued by the butcher.

If cost and value are the same, it can only be a coincidence. The value of anything, naturally, must be measured by the conditions existing at the date of the valuation. Cost incurred at another period and under different conditions, certainly cannot measure value.

If one will study performance of telephone companies, gas companies, manufacturers, etc., it will not take long to realize that no two institutions can produce the same thing at the same time at the same cost. One grows strong while the other becomes bankrupt, even though the general efficiency and capability may be somewhat equal. Whose stock would have the higher value?

A great deal has been said and written about so-called tangible and intangible values. Tangible values are supposed to represent physical values, while the other represents good will, going value and countless other expressions.

The Supreme Court of Wisconsin in the Appleton case discussed this division thus: "However, the fundamental difficulty with an attempt to set a definite sum as the measure of *going value* is that it is an attempt to divide a thing which is in its nature practically indivisible.

"The *value of the plant and business is an indivisible gross amount.* It is not obtained by adding up a number of separate items, but by taking a comprehensive view of each and of all the elements of property, tangible and intangible, including property rights, and considering them all, not as separate things but as inseparable parts of one harmonious entity, and exercising the judgment as to the value of that entity.

"In this way the going value goes into the final result but it would be difficult for even an expert to say how many dollars of the result represents it."

Thus it seems that the value of public property is a question of law and fact, but in all cases, value must be made from the commercial standpoint.

The Texas commission was overruled in a case against a Texas railway.

"It seems clear from the answer of the commission that in estimating the value of this railroad, no allowance was made for the favorable location of the same, in view of the advance in prosperity of the country through which it runs, and *the increment to its value* due to the settling, seasoning and permanent establishment of the railways, and to the *established business* and *good will* connected with its business, which has been established through a long series of years, and all of which ought reasonably to be considered in fixing the value of the property and the capitalization upon which at least it is entitled to earn, and should pay, some returns by way of interest or dividends."

A telephone company has a value beyond that of mere physical value. Justice Brewer of the United State Supreme Court in the Kansas City waterworks case, said: "A complete *system of waterworks* such as the company has, *without a single connection* between the pipes in the streets and the buildings of the city, *would be a property of less value* than that *system, connected* as it is, with so many buildings and earning, in consequence thereof, the money it does earn.

"The fact that it is a system in operation, not only with a

capacity to supply the city, but actually supplying many buildings in the city—not only with a capacity to earn but actually earning—makes it true that the fair and equitable *value is something* in excess of the cost of reproduction."

The lean years' theory or deficit theory, as well as the cost of procuring business in arriving at the tangible value, is shown by the court in an Oklahoma case.

"It is apparent, however, that a complete telephone plant without a single subscriber or with but few subscribers, is less valuable, both to the owner of the plant and to the members of the public it serves, than the same plant with a large patronage.

"The more people a subscriber can communicate with, over a telephone exchange, the more service, as a general rule, is such exchange to him—and *it is only when such exchange has subscribers* that the property of the owner invested therein has an earning power."

Now follows the same decision with a bearing upon a particular cost which every telephone man knows exists. No telephone company ever secured a new subscriber at less than $5 expense.

"But *subscribers are not obtained without expenditure of money, labor and time,* during which the *capital invested* in the plant *earns nothing* and often *fails* to pay operating expenses.

"The customers must be connected with the system, trained employes must be obtained, and a system of operation established.

"Few industries, if any, involving an investment of $50,000 or more can be made self-sustaining from the first day of their operation.

"The *appelant's plant,* for the years preceding the first hearing, failed to produce enough revenue sufficient to pay operating expenses, current repair and lay aside enough for depreciation."

Again follows the great question so often brought up by public enthusiasts that such early deficits are to be borne by the corporation itself. But telephone companies have a perfect right to charge every dollar of loss to the public.

"During the time of development, there is a loss of money actually expended and of dividends upon the property invested.

How shall this be taken care of?

Must it be borne by the owner of the plant?

Or by the initial customers?

Or shall it be treated as a part of the investment or value of the plant, constituting the basis upon which charges shall be made to all customers who receive the benefit from the increased service rendering power of the plant by reason of these expenditures?

It seems that the last solution is the logical, just and correct one."

Such a decision should clearly show every board of directors that a telephone company has even a right to capitalize its losses. It is plain that no telephone company can charge the public suddenly for past services rendered. But it is possible that the company can charge the public interest on the money so wasted.

Suppose the Brown Telephone Co. had gone along and neglected its depreciation fund entirely, whether from ignorance or conviction. It does not alter the public's responsibility in the matter, because they used up the property without proper compensation. Hence they can create a new reserve at the expense of the real party who wore out the property by usage.

It can be added that there are commissions who do not care about law or decisions. Hence many commissioners take the law to themselves because they have the whip hand. But it has been shown that the powers of the courts have not been changed by the commission law, and that the right of appeal to the courts still exists.

No rights have been abridged and no man need bow his head to any decision of a commission which ignores his economic rights. A commission must be guided by economic rules which govern the world today in valuing property devoted to commercial purposes.

The very economic condition, today, justifies a raise in rates even without a hearing, because every product known to mankind has increased in price.

No commission has a real right to sit tight on a telephone company, while contemplating the soaring of prices of every other commodity. Such a statement reminds one of the lawyer who told his client already in jail that they could not put him in jail for that particular crime, even though he was already there.

It is true that commissioners can reach conclusions satisfactory to themselves which are not all sound. But it must be remembered that the courts are still in existence, and enough opinions have been quoted to show that a telephone company has a real chance to earn enough to perpetuate itself.

Where has the $150,000 gone which have been expended by the Brown Telephone Co.?

A reproduction new cost gave it a physical value of but $150,000. But the engineers of the commission found the property to have a depreciated physical value of $127,500, or 85 per cent. good. Is that the proper investment figure to base rates on?

What will become of the $32,500 of impaired capital which has been devoted to the public? Does anyone think it should be lost?

That $32,500 has been really spent as follows:

Cost of organization	$10,000
Cost of contracts	10,000
Cost of financing	8,000
Working capital	4,500
Total	$32,500

The $127,500 represents the pipes in the street and the $32,500 represents the cost of connecting the consumer to the pipes. Who dares to say that the $32,500 is not as much a valid charge of the $127,500 charge for physical value or the bare bones of the property?

To reject this charge would be no more absurd than to refuse to allow for labor, effort which after being exerted, no longer has any redemption or junk value.

MORAL: To be concluded in our next.

Citizens Company of Grand Rapids to Issue New Bonds.

The directors of the Citizens Telephone Co., of Grand Rapids, Mich., recently authorized a general mortgage of $3,000,000 as a basis for an issue of 20-year, 5 per cent. bonds to the same amount, the plan having been approved by the Michigan Railroad Commission. Of the authorized issue, $600,000 will be offered to investors at par on December 1, 1916, for the purpose of refunding the company's 6 per cent. bonds which were issued in 1913 to meet an emergency when the company was compelled to pay deferred state taxes which had been in litigation. This new bond issue will also provide for the company's financial needs for many years to come.

The old 6 per cent. bonds will be called at 102, payable February 1, the semi-annual interest period, and will be retired. By the terms of the general mortgage, additional bonds can be taken down when money is needed for improvements, extensions and other purposes, but this is rigidly restricted.

This bond issue is trusted by the Michigan Trust Co. and the Grand Rapids Trust Co. jointly, and the bonds to be sold have been underwritten by the joint trustees.

"Telephony's" Home Study Course for Telephone Men

A Complete Presentation of the Principles Underlying Modern Telephony in All Its Branches—Arranged Systematically So That Regular Reading and Faithful Study Will Qualify Ambitious Men for Higher Positions—Prepared Under Supervision of Stanley R. Edwards—This Section Written by Jay G. Mitchell

Quiz Questions on the Preceding Installment.

498. What is the distinguishing characteristic of Planté storage battery plates?

499. What is the distinguishing characteristic of Faure storage battery plates?

500. State the advantages of Faure plates.

501. What two indications may be used for routine testing of storage battery cells?

502. What is the principle underlying the constant-weight hydrometer?

503. Why must lead or lead-covered bus bars be used in joining the plates of a storage cell belonging to the same group?

PRACTICAL TALKS JUST AMONG OURSELVES.

When the Fosterville exchange was first converted to common battery equipment, the chief installer, upon leaving, turned over to the local force operating instructions for the new apparatus. These comprised blueprints of circuits and other information regarding the power equipment as well as the purely telephone part of the installation.

It was specified that each of the two sets of battery, eleven cells per set, should be charged on alternate days for eight hours at a uniform rate of ten amperes. Emphasis was placed upon the necessity of immediately recharging the set retired from service so that it should not be left standing idle while in a discharged condition. The discharge circuits leading from the power switchboard were, accordingly, switched from one battery set to the other on alternate mornings. The battery relieved was at once placed on charge and kept there for eight hours at approximately ten amperes for the entire time.

In the absence of specific instructions on this point, the voltage readings of the individual cells were never taken. Not only was the specific gravity of the electrolyte entirely neglected but the hydrometer, if the plant had ever possessed one, was unknown. Each set of battery was charged for eight hours *by the clock* on alternate days.

The installation of the common battery equipment and the up-to-the-minute methods of the wire chief, improved the service in Fosterville so much that the number of subscribers increased steadily. Not only the excellent service but the natural growth of the city also contributed to this result. As the list of telephone subscribers became longer, the traffic through the switchboard necessarily became heavier and soon the installation of an additional operator's position was found to be required.

It had never occurred to the wire chief that the total amount of energy to be furnished each day by the battery must *increase* with the traffic through the switchboard. The reason for this was, undoubtedly, due to the failure of the most conscientious storage battery to get hot, burn up, or squeak when driven beyond the safety point. Therefore, while the number of calls to be fed with power each day had increased at least 50 per cent. over the amount being handled when the batteries were first installed, the *same* amount of energy was available, due to the inadequate charging schedule, as there had been when the equipment was new.

When the new position was cut into service, reports of dim switchboard lamps became frequent in the afternoon immediately preceding charging day. New subscribers located far out in the outskirts of the town failed, at times, to get the operator when calling in. The selective ringers also failed, at times, to operate when they should, on the afternoon immediately preceding charging. It was perfectly evident to the wire chief, since he had formed the habit of using his head, that there was some connection between these general cases of trouble and the alternate day for battery charging. In other words, he concluded that these troubles were due to a general condition that was not present whenever the batteries were freshly charged.

Right then and there this wire chief determined to try out some of the storage battery theory that had been touched upon in TELEPHONY's Home Study Course. He ordered a hydrometer from the battery factory. When it arrived he found packed with it a pamphlet containing good storage battery information. Each cell in all the batteries was then numbered, its number being obtained by beginning with number one for the cell which formed the positive terminal of each battery.

In the main sets in Fosterville, the negative terminal cell would, therefore, always be number eleven. A careful record of the specific gravity of the electrolyte of the individual cells, based upon the readings that were taken *after* the completion of the eight-hour charge, was made and preserved for future study. It was found that there was a variation of the specific gravity of the electrolyte in different cells from the extreme low reading, 1,075, to the high one, 1,280.

The voltmeter on the wire chief's desk had two scales, 0-150 and 0-5. It occurred to the user of this most completely appointed piece of office furniture, that this low-value scale on his voltmeter was probably for the purpose of enabling the wire chief (himself) to take individual cell voltage readings. When the taking of these readings was attempted, it was found that wires from the voltmeter placed upon the cell terminals did not give reliable results owing to the impossibility of obtaining perfect contact. Wire nails were accordingly

mounted in wooden handles and soldered to lamp cord leading to the voltmeter. It was then found that a very slight pressure served to force the iron points through the layer of refuse and acid found on the lead terminals of the cells.

In this way it was possible to obtain very accurate and steady readings of the individual cell voltage. These readings of cell voltage were carefully recorded with the readings of specific gravity of electrolyte, the same system for identifying individual cells by number being used. It was found that the voltage of the individual cells ranged from 2.2 volts for the low one to 2.6 volts for the high one at the end of the regular charge.

An inspection of the cells with an electric lamp held in position so that the light passed through the sides of the glass jar and between the plates showed, in many cells, masses of active material loosened and wedged between positive and negative plates. Such particles of active material might, it would seem, form an electrical connection between a positive plate and a negative.

In cells where this condition was found to exist, the specific gravity of the electrolyte and the voltage across the terminals at the end of the charge was generally low. After reflection, being a man of discernment, the Fosterville wire chief concluded that such cells were being subjected to a continuous discharge of small current strength through the high resistance circuit formed by the masses of active material lodged between the plates. He also believed that should this be true, it would fit in well with the observed low specific gravity and voltage readings in these cells.

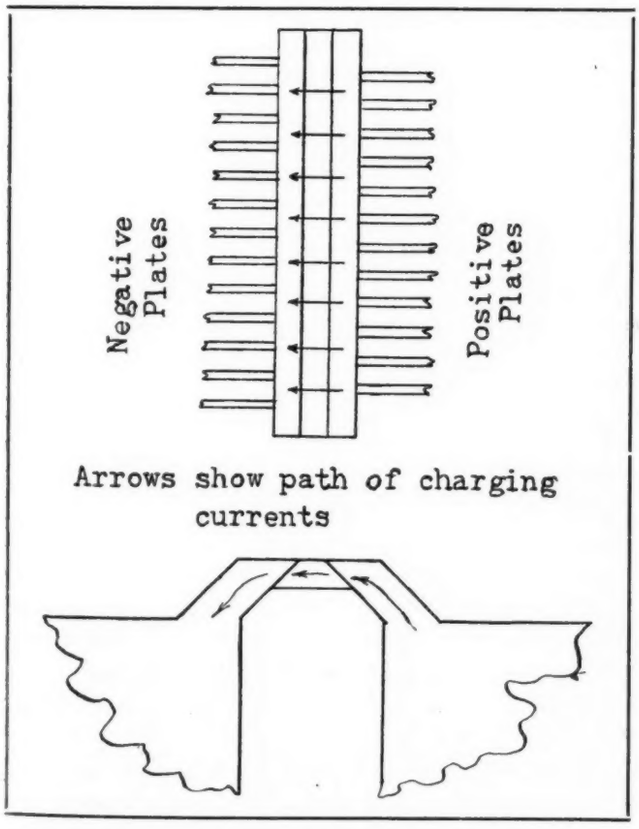


Fig. 170. Connection Insuring Uniform Distribution to Plate.

Using a very thin piece of wood, free from *all nails* and *other metals,* he carefully pushed the disturbing pieces down between the plates into the open space at the bottom of the jar. The sediment in this space was not deep enough to reach nearly to the lower edge of the plates and so it was very wisely decided to leave it undisturbed.

After all the individual cells had been very carefully inspected and cleared of particles lodged between the plates, the record of voltage and specific gravity readings was very carefully gone over. While several of the cells showed serious irregularities, one in particular was selected for the first trial of special treatment. The next morning, ordinarily the day on which no charging was due, a pair of insulated No. 14 iron wires was laid on the floor from the power switchboard to the storage battery room. Iron wire was used because it was intended to use the regular charging outfit for extra charging of only *one cell* and it was necessary to include some resistance in the charging circuit in order to cut down the voltage, high enough to charge eleven cells in series, to that suitable for use with only one cell.

The iron wire was connected to the terminals of the charging circuit at the power switchboard using the side of the main switch not connected to the main *battery* terminals. After testing to determine the polarity of the two wires, the one connected to the positive side of the charging circuit was clamped to the positive terminal of the crippled cell and the other one to the negative side, a double pole switch and fuse block fused at 20 amperes being inserted in the temporary circuit within easy reach of the power switchboard. With everything arranged as it would be in charging the entire battery, except that the main switch was not closed, the temporary switch was very cautiously closed and the current adjusted to ten amperes by the usual means.

In this way the badly crippled cell was given a booster or extra charge. This extra charge was repeated and continued on this cell and the other cripples until their voltage and specific gravity readings had been brought up to a point approximately the same as the best cells.

The wire chief found that a surprisingly large amount of this kind of work was necessary. However, he persisted until conditions were more satisfactory and found to his surprise that the improvement in the weaker cells had the immediate effect of reducing the amount of general trouble due to low battery voltage. After all the cells had been brought by this method into approximately the same condition, daily readings and records of the specific gravity and voltage of each individual cell were made a part of the exchange routine.

Permanent records of these readings were kept. As a result, it was demonstrated that charging on alternate days for a period of eight hours was not sufficient for the exchange load being carried. The schedule was changed so that the two main sets of battery were charged alternately, and one of the sets was charged *every* day. It was not found necessary to charge each set for eight hours each time, but it was clear that even when fully charged the battery capacity was not great enough to carry the exchange for 48 hours.

When the work on the batteries was finished, the wire chief felt that the telephone business was making insistent and constant demands for progress and that it was always possible to

learn something new. He also found that when there was not time to do all the charging in the day time, it *could* be done, in emergency, very easily at night when the exchange load was light.

CHAPTER XII. Power Plant Principles (Continued).

504. *Connection of plates and cells of a battery.*—In large capacity cells in lead-lined tanks, the *positive* plates

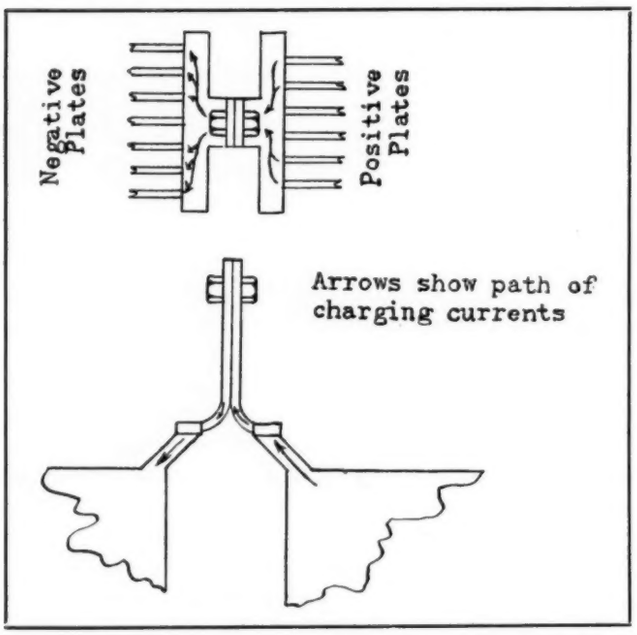


Fig. 171. Connecting Strap Terminal for Storage Cells.

in the one cell are always connected directly to a massive lead-covered bus bar to which the negative plates of the neighboring cell are also connected. In this way the current flowing from one cell to the other is equally distributed between all the connected plates of each cell. At the terminals of the battery of cells, where the final cell is connected to the charging and discharging circuit, a similar lead-covered bus bar of copper is used so that all the plates at the terminal of the entire *battery* will be equally worked both on charge and discharge.

The principle of the bus bar between cells is illustrated in Fig. 170 which is supposed to show the top view of a bus bar joining 13 negative plates in one cell to 12 positive plates in another.

In smaller cells in glass jars the connection between cells is more likely to be like that shown in Fig. 171. With this arrangement it is obvious that the end plates, at high rates, will receive charging current and deliver discharging current through a greater resistance than those near the center. In such a case it would be somewhat better practice to utilize a smaller number of larger plates rather than a large number of smaller ones connected by a long bus bar of lead.

505. *Installation of additional plates.*—When new batteries are installed, it is quite customary to provide jars or tanks having a greater capacity than that required for the number of plates to be furnished at once. This is done so that additional plates may be installed when the growth of the exchange, if they are installed in a telephone office, requires additional battery capacity.

Such a plan is perfectly feasible provided the new plates are not installed in the same jars or tanks with old ones. The battery must be entirely dismantled, and then reassembled with new plates associated only with new plates and the seasoned plates with other old ones. Should the new plates be installed in the same jar as more seasoned plates, they would not receive their proper share of the charging current and would not contribute their proper share of the discharging curent.

The reason for this is that new plates show a higher electromotive force on charge and a lower one on discharge than old plates. In fact, the voltage across the terminals of any complete cell is lower when the cell is old and seasoned than it is when the cell is new. The same may be said of the specific gravity of the electrolyte for any given condition of charge.

By placing new plates in the cells with other new plates, the electromotive force of the *individual plates* is equalized both on charge and on discharge and both old and new are assured of the same treatment. The same is true of the older plates which would be called upon for more than their share of the discharge and would receive less than their share of the charge if placed in the same jars or tanks with new plates.

(To be Continued.)

Earnings of the Keystone Telephone Co.

The Keystone Telephone Co., of Philadelphia, Pa., has issued its comparative statement of earnings for the combined companies, for the month ended September 30, 1916, and for the nine months ended on that date, as follows:

	For month ended Sept. 30, 1916	Year Previous	For nine months ended Sept. 30, 1916	Year Previous
Gross earnings	$124,129	$114,993	$1,087,344	$1,014,147
Operating expenses and taxes	63,202	56,789	549,457	503,981
Net earnings	60,927	58,204	537,887	510,166
Less interest charges	27,453	26,907	247,076	239,380
Net surplus	$ 33,474	$ 31,297	$ 290,811	$ 270,786

To Vote on Municipal Telephone System in California.

At the general election, November 7, the voters of the cities of Modesto and Turlock, Cal., and the unincorporated territory of the Modesto and Turlock irrigation districts will vote on the initiative proposition of organizing a public utilities district for the purpose of municipal management of the telephone lines and exchanges in that territory. The movement for this election has been fostered by the United Telephone Association, a body composed of all the farmers' telephone companies connecting with the Turlock and Modesto exchanges, and is the result of rate disputes between the farmers and the Pacific company.

Reports Trend Favoring Municipal Ownership.

Morris L. Cooke, director of the public utilities bureau of Philadelphia, Pa., in speaking before the League of Kansas Municipalities, at Independence, Kan., last week, stated that there was an unmistakable trend toward municipal ownership in the handling of municipal affairs. At the same time, he declared, some of the great corporations which specialized in public utilities are doing all they can to prevent municipal ownership.

Fayette Home Company Issues Additional Stock.

The Fayette Home Telephone Co., at Lexington, Ky., has issued an additional $25,000 of stock which will be distributed pro rata among the present stockholders. The proceeds will pay for improvements to the property.

Practical Subjects—Letters and Discussions

A Manufacturer Discusses the Increasing Cost Problem.

As one responsible in a large measure for the future and the destinies of one of the smaller Independent telephone manufacturers, I wish to thank J. C. Kelsey for the excellent work he is doing in trying to impress on the $1 and $1.50 telephone exchanges—and the $1 and $2 ones as well—that they must get away from these 1896 rates if they are to survive. My purpose in writing is to ask that he more thoroughly emphasize the fact that they must do this themselves, and that this is one task which they cannot "wish" on the manufacturer.

As the future of my business is dependent on the success of the Independent companies and as their financial welfare will be the true measure of my own, I have been deeply grieved by the manner in which many of my customers have met the recent necessary advances in the cost of telephone materials. Not a single case has come to my notice where Mr. Kelsey's excellent articles and the present high costs have been taken advantage of and made the basis of newspaper publicity in non-commission states and in states which have commissions. I am sorry to note that practically all applications for increased rates are from Bell-owned plants.

The majority of our low-rate customers have taken the advances stoically and without comment or action of any kind. They are still going along working for nothing and making no effort, either to secure advanced rates or to lay a foundation for so doing.

Of course, the letters we do get regarding prices on equipment are letters of protest. Some are rabid and accuse us of all manner of dire conspiracies, claiming there is not the least foundation for the present prices; that they know where they can get good equipment from a manufacturer, not a party to the present "conspiracy," and threatening to do so unless we withdraw the advances in their case, in appreciation of former patronage and good words spoken in behalf of our equipment.

All we can do is to politely and firmly refuse to be bluffed in this manner, and to remind our customer that he is able to place his orders at a definite price with assurance of a reasonably prompt delivery, while we are vainly awaiting delivery of material ordered eight months ago. In response to our inquiries regarding material for our future requirements, we get only the stereotyped: "If you care to place your order, we will fill it as soon as we can, at whatever prices may prevail when delivery is finally made."

We are sorry to see some of our former customers make good their threat by withdrawing their account, and then pay as much or possibly more than our new prices, elsewhere. On the other hand, we have received many new accounts which have come to us as a result of the equal necessity of our competitors advancing their prices to a living level.

Why don't these telephone men devote their attention and energy to making the public pay them instead of criticising their innocent and faithful manufacturers? And right here I wish to direct attention to the harsh and thoughtless treatment often accorded the manufacturer by the telephone manager.

The representative of a raw-material house was telling me the other day of the chaotic conditions prevailing years ago in the implement business, during the times of over-competition. Free repairs of all kinds were the rule rather than the exception. A farmer would buy a new binder, skid it into a ditch, and break the tongue into two pieces in getting it out. Some barb wire and a cottonwood sapling would be the character of the splice. If the machine missed one bundle in a thousand, the implement dealer would have to make a long drive to adjust the knotter.

Seeing the rickety tongue, the implement man would warn against the inevitable accident, and suggest that a new tongue be put in. On receiving a curt "can't-afford-it." the usual reply was: "Well, bring the old broken one in in even exchange for I can't afford to have out a New Chief binder with a tongue like that you are using."

Thus spoiled, the farmer became very adept at demanding even exchanges on all worn and broken parts. The implement man instead of paying for repair parts, shipped back a lot of scrap to the manufacturer, who thereby lost most of the meager profit he had figured on the original transaction. Nor did the guilty implement dealer escape. He made a wonderful record—sold 90 of the new model binders the first season they came out. But among the 90 purchasers were many whose notes the banks would not touch.

Besides about 87 of the 90 binders were left in the "big shed" (out doors), at the close of the season, without a single knotter being smeared with grease. Next season, harvest came on with a rush. Owing to their "improved" design, these knotters, now thoroughly rusted, broke the twine and would not tie. Consequently, Mr. Implement Dealer was so busy shooting trouble and his machines were in such disrepute, that his sales dwindled to nothing and he lost his agency.

He could not charge for his trouble-shooting services, for Mr. Farmer had previously worn out two McCormick binders —had always left them under the same tree, and they always brightened their own knotters during the first "round." This was perhaps true, but the rusting of a knotter for a year to see if it would tie or break the twine, is a test which the manufacturer's mechanical engineer could hardly be expected to make.

Things went from bad to worse. Competition became keener. Dealers vied with one another as to who could give away the most repairs. The farmers continued to leave their binders out doors and bought a new one every four years—usually something different from what they previously used, in a futile search for one that would run without oil and give perfect satisfaction. Finally one very courageous manufacturer read a paper before the national dealers' association, entitled: "The Spoiled Farmer." But instead of blaming the "spoiled farmer," the paper was wholly devoted to the dealer who had spoiled him, and clearly showed up the ridiculous situation then prevailing.

This paper created a sensation and not a little resentment. We are sorry to record that it was eagerly seized upon by the representatives of competing manufacturers and the word went down the line to almost every farmer in the land to keep away from M. Irons & Co., who had refused to stand behind their equipment. The business of the courageous manufacturer fell off severely. But from his sacrifice, and as a result of his courage, better conditions now prevail. Farmers are paying $40 more for binders and are paying for repairs. As a result of the latter practice, they are taking so much better care of their equipment that the machinery cost per acre is less than in the old days of cut-throat competition, free repairs, and wasteful methods.

It is not difficult to see the application of this story to the abused telephone manufacturer, the spoiled subscriber, and the telephone company, between, which is more willing to criticize the manufacturer than to "unspoil" the subscriber. I believe, however, that the average manufacturer has been just as guilty in spoiling the smaller telephone companies as such companies have in spoiling their patrons.

When the exchange at "Six Corners" was built in 1906, one of our representatives with previous construction experience, spent two days "spotting the house," after which he sent in a mess of sketches which our engineering department had to reduce to respectable prints, all of which engineering was done gratis. Our representative, in his further eagerness to make the sale of the entire equipment, agreed, outside the written contract, to install the new board on a regular trip without

extra charge. But the customer in his eagerness to get the board set up, waited only two days after notifying our man, and then allowed the outside construction man to set it up one Sunday.

For this he deducted $15 from the invoice, notwithstanding our man was there the next day and spent more time helping and advising with the other work that the board's installation would have required. Our man, furthermore, made a return trip, at the customer's request, to instruct the operator when service was started. Something over a year later he voluntarily cut back all the cords. The result was that about two years thereafter, we received a request for longer time on an overdue account with this curt request at the bottom: "Why don't you send your man Dawson around any more, our cords are getting in bad condition?"

There you have a typical example of the telephone man with the wrong viewpoint, and we trust your articles will help to reduce his number.

Why was he behind in his account? Rates too low. Why doesn't he hire someone who knows how to give a switchboard decent maintenance? Can't afford it. Why doesn't he learn to cut back cords himself? Hasn't the time or inclination.

In fact he is kept too busy with other interests which he has to look after, in order to live. Can't the telephone company pay a good man to give the business his undivided attention? No, it is continually "hard up" as it is. Reason? Rates too low.

This particular company drifted away from us when the officers got the idea that by dividing their account, they could get more and longer credit. As a result, they have bought almost everywhere. Now they are "cussing us out" for raising the prices of our telephones to a "prohibitive figure."

If you can do anything to show some of these starvation-rate companies that they can no longer "get by" with their insufficient rates, low-switching charges, and free service, through working for nothing themselves and by riding the manufacturer to death for free service and free repairs, and can really get them to go to the root of all trouble and get more revenue from their patrons—you will have done a work of inestimable value to such telephone companies, their patrons and the manufacturers, 95 per cent. of whose grief now comes from such underpaid companies.

Constructive Manufacturer.

The Testing of Dry Cells.

In TELEPHONY of October 7, J. H. Schmidt, the engineer of a company manufacturing dry batteries, is given space to question the truth and value of certain statements in a paper read by H. N. Faris before the last annual meeting of the Oklahoma Telephone Association. As it is very evident to me that his criticisms are based on a misunderstanding of Mr. Faris' article, no doubt from a hurried perusal of it, I wish to call attention to the fact that Mr. Faris' suggestions pertain wholly to the testing of *old* dry cells, so that we may know when to remove them from service, while Mr. Schmidt seems to be trying to tell us how to conduct comparative tests between *new* dry cells of different makes.

Mr. Faris' paragraph is here quoted in full to show that he had in mind such *discard* tests as can be made by the ordinary lineman and trouble-shooter with such qualifications and apparatus as is generally found in the average Independent exchange in Oklahoma, of which there are several hundred:

> A great deal of misunderstanding seems to exist relative to what tests should be made on dry cells, to determine when they should be removed from transmitter service. The specifications of one prominent manufacturer require a battery that will show 2.8 volts when on duty in the transmitter circuit. This requirement is far too severe, as a pair of brand new dry cells in perfect condition will barely pass it and would have to be changed every few weeks to be kept up to this standard, which really amounts to a requirement that three dry cells be used.
>
> The writer's idea would be to use two dry cells only, and not discard them until they fail to show 1.6 volts per pair while connected to a 22-ohm transmitter circuit. As transmitters vary in resistance, it is advisable to use a 25-ohm shunt on the voltmeter when measuring used batteries, as this causes the battery to show what it can do on a transmitter circuit of approximately 22-ohms' resistance.
>
> However, owing to the greater ability of certain transmitters to talk well on weak battery, the writer believes a side-tone ear test with the telephone short-circuited, to be preferable for small plants. Straight voltmeter or ammeter tests should not be used, as neither is indicative of a battery's ability to furnish good transmission.

Now Mr. Faris does not refer to a single dry cell testing 2.8 volts—even ordinary people out in Oklahoma know that "they aint no sich thing"—but he does call attention to the inconsistency of one manufacturer. The latter encloses a specification with his transmitter asking that the battery be kept up so it will maintain 2.8 volts across the transmitter terminals, and then builds his telephones so they will hold only two No. 6 size dry cells. Just as Mr. Faris says, a pair of brand new dry cells will scarcely pass this requirement. As the telephone will only hold two dry cells, to follow the manufacturer's instructions would require us to be constantly changing batteries, or we would have to put two cells inside and hang one cell on the outside of the telephone in order to comply with a transmitter specification promulgated at a time when the manufacturer was trying to force us to adopt three dry cells for telephone work instead of two.

Had we not balked at the three-cell order, where would we "be at" now in these high-pressure days of high-pressure-priced batteries, it having been my experience that three cells have to be renewed oftener than two cells? I believe in our state, not one magneto telephone in 500 is equipped with three cells of batteries. Two cells are generally accepted as standard here and for every telephone operated with three dry cells, there are 20 that are operated with one cell—and there are going to be more so operated if we don't get a better quality of cells than those for which we are now paying such fancy prices.

Three cells may be all right for Mr. Schmidt and the Electro-chemical Society. Mr. Schmidt's company has batteries to sell and the E. C. S. doesn't have to buy any for telephones.

Mr. Faris' statement further says that "straight voltmeter and ammeter tests should not be made." This also refers to the testing of old dry cells to determine when they should be discarded.

We all have a fair working idea of what tests to make on a few cells in each fresh barrel we receive, and Mr. Faris gave us some instructions, which I have since found practical and valuable, in determining when to discard old batteries.

Mr. Schmidt suggests we await complaints from subscribers as to not being able to hear. I presume he then wants to find out who it is they can't hear and then for us to make a trip to this telephone, which may be several miles out in the country, and install a pair of new batteries. My 20 years' experience in magneto telephone plants has taught me to avoid the expense of those special trips by periodic inspection and to keep the good will and esteem of my patrons by renewing batteries at the proper time instead of awaiting complaints. I have also learned in those little exchanges of less than a thousand subscribers, that patrons can usually find enough things to complain of without throwing out any special inducements.

I have great respect for Mr. Schmidt's ability and his knowledge of battery chemistry, but regret that he cannot appreciate the value of the discard tests recommended by Mr. Faris which I have been trying out since last February, and which I know by experience to be practical and helpful.

I believe that the elaborate tests recommended by the electro-chemical society should be frequently made by competent en-

gineers for the state and national associations, and the certified results of such tests be published.

It appears mysterious to me, as well as to many telephone men with whom I have talked on the subject, that with all telephone manufacturers now reconciled to the two-cell idea and all of them making every effort to secure standard transmission from two dry cells with the lowest current consumption possible, we continue to get shorter and shorter life from each pair of batteries installed. Ten years ago, 12-ohm primary circuits were very common indeed, but batteries gave a far longer life than they do now in the same stations on new primary circuits measuring from 20 to 30-ohms.

I do not care to enter into any correspondence or newspaper argument with Mr. Schmidt, but I do hereby extend him a cordial invitation to meet with our association at Oklahoma City the 19th and 20th of next February, and explain how we can get as long life out of the high-priced 20 to 30-ampere dry batteries of the present day, as we did from the 12 and 14-ampere dry batteries of the same makes purchased 15 years ago when telephones were crude and had much better appetites for current than they do now.

Oklahoma Telephone Association,
Geary, Okla. By Horace Truman, President.

Long Life of Northern White Cedar Poles.

In TELEPHONY of September 16, mention was made of tests of the life of cedar poles made by a Minneapolis dealer in Western and Northern cedar, in which a life of 17 years is attributed to this class of poles. As indicating that such a service is not exceptional, other instances have been brought to our attention of the long life of Northern white cedar poles.

During 1904 a member of the Northern White Cedar Association sold a number of poles to the Citizens Telephone Exchange, at Montevideo, Minn., regarding which the company wrote under date of April 4, 1916, as follows:

"The poles purchased from you in 1904 have given great satisfaction. So far we have not replaced any, except the ones

Poles 26 Years in Service Are Expected to Last Until 1926.

destroyed by lightning. Most of them appear as if they will withstand decay for another 12 years."

About the same period the Burbank Telephone Exchange, Burbank, S. D., purchased similar material, regarding which its manager had the following to say in April, 1916:

"I put a great many of your poles in service in 1904 and 1905 and some of them are still good and many of them were placed in water. I can say that your poles are hard to beat."

In one of the accompanying illustrations is reproduced a photograph of East Lake street, Minneapolis, Minn., looking west from 40th avenue, south. This displays a line of 40 ft. Northern white cedar poles, the property of the Minneapolis General Electric Co., which have been in the ground for 17

Poles Set 17 Years Ago Are Expected to Stand Nine More.

years. As the result of an inspection during the past summer the expectancy of life on these poles was fixed at nine years.

The other illustration shows a portion of the Minneapolis General Electric Co's. lines on 15th avenue, northeast, in the vicinity of 6th street. These 40 ft. poles were set 26 years ago and this summer's inspection indicates that nine years more service is expected.

A similar line of poles belonging to the same company is on Hennepin avenue from 8th to 10th street. These, too, have given service for 26 years and are expected to last at least until 1925.

The instances cited relate entirely to Northern white cedar. Should any of TELEPHONY's readers desire to become more fully acquainted with actual examples of the long life of white cedar, Secretary N. E. Boucher, of the Northern White Cedar Association, states that the association will be glad to escort them to attractions along this line in Minneapolis, and the vicinity. Mr. Boucher's office is located at 743 Lumber Exchange, Minneapolis.

The Origin of the Word "Hello."

A distinguished philologist states that "Holler" is the word halloo in its proper form, and halloo is a root common to all Indo-European languages. The root is spelled in the comparative grammar of the Indo-European language, by Heinrich Fick, Hlu, and is pronounced almost exactly, h-loo. It appears in whole classes of words signifying to call (call itself being derived from that root), and to hear, and meaning very nearly, "stop and listen to me."

The first word in the old Norse Edda is Hlioths, and it means a listening silence, so that the concrete meaning of halloo is, to be in state of listening silence, or "be still and listen." This is one of the most interesting philological contributions to the literature of the telephone, illustrating the exact meaning of the word "hello."

To Build Line Between Barbourville and Manchester, Ky.

The Tri-State Telephone Co., of Bush, Ky., has begun the construction of a long distance line from Barbourville to Manchester, Ky., a distance of 24 miles.

Personal Items from the Field

W. R. McGovern, formerly state engineer for the Chicago Telephone Co., has been appointed chief engineer of the Central group of Bell telephone companies. Mr. McGovern is a native of Milwaukee and a graduate of Marquette University. He started in the telephone business in 1899 with the Erie system, which embraced the Wisconsin, Michigan, Northwestern, Southwestern and Cleveland companies.

W. R. McGovern.

When the construction department of this system was abolished in 1901, he went with the equipment department of the Wisconsin Telephone Co., at Milwaukee, running the gamut of traffic, maintenance and construction work, holding such positions as traffic inspector, equipment installer, line foreman, etc., finally working up to equipment engineer and chief engineer of the Wisconsin Telephone Co. His experience in these positions has included most of the work from making blueprints to the engineering and construction of the largest exchanges in Wisconsin, including a part of Milwaukee.

When in 1911 the Wisconsin, Michigan, Cleveland, Central Union and Chicago telephones properties were grouped into one operating unit, known as the Central groups of Bell companies, Mr. McGovern was transferred to Chicago and appointed to the position of engineer of inventory and appraisals for the five companies. On August 1, 1912, he was appointed to the position of engineer for the state of Illinois, embracing all the property of the Chicago Telephone Co., city and suburban, and the Central Union Telephone Co. in Illinois. In 1914, the property of the Central Union in Illinois, having been placed in a receivership, he was withdrawn from the state engineering department.

Mr. McGovern is an associate member of the American Institute of Electrical Engineers, a member of the Chicago Association of Commerce, the Traffic Club and the Electric Club.

A. R. Castle has been appointed manager of the Hubble Telephone Co., at Stanford, Ky., succeeding A. P. Sloan.

R. E. Smith, of Pittsburgh, has been appointed local manager of the Bell Telephone Co. of Pennsylvania, at Reading, Pa.

I. R. Allen has been made manager of the Boone and Ogden (Iowa) exchanges of the Boone County Telephone Co.

J. S. Ford, formerly building engineer in the state engineering department of the Chicago Telephone Co., has been promoted to the position of state engineer, succeeding W. R. McGovern.

John O. Beam, for the past year local manager of the Bell Telephone Co. of Pennsylvania, at Reading, Pa., has been transferred to Harrisburg, where he will be detailed on special work.

D. R. Savage, for the past six years manager of the Windom and Jeffers, Minn., exchanges of the Tri-State Telephone & Telegraph Co., resigned a short time ago to accept an appointment as state engineer of roads.

J. A. Davenport, district plant chief for the Missouri & Kansas Telephone Co., at Chillicothe, Mo., has purchased all of the stock in the Hale Telephone Co., located at Hale, Mo., assuming possession on November 1.

F. A. Day, local manager for the Mesaba Telephone Co., at Hibbing, Minn., for the past five years, recently severed his connections with the company to become cashier for the Northwestern Telephone Exchange Co., in St. Paul.

George B. Wellbaum, for a number of years advertising and sales manager for the Dallas Automatic Telephone Co., at Dallas, Texas, recently left Dallas to become commercial superintendent for the Indianapolis Telephone Co., of Indianapolis, Ind.

W. L. Smith, of Neillsville, Wis., long a prominent figure in the councils of the Wisconsin State Telephone Association, having served several terms as president of the association, has been nominated on the Republican ticket for the office of assemblyman.

James I. McDonald has been promoted to the position of building engineer in the state engineering department of the Chicago Telephone Co., succeeding J. S. Ford. Mr. McDonald was formerly general building inspector in the state engineering department.

B. R. Marsh, formerly district manager of the Michigan State Telephone Co., with headquarters at Lansing, Mich., has been promoted to assistant superintendent and district manager of the Detroit district and superintendent of plants and exchanges outside of Detroit.

Donald B. Robinson has recently been appointed manager of the Windom and Jeffers, Minn., exchanges of the Tri-State Telephone & Telegraph Co., with headquarters at Windom. For the past three years, Mr. Robinson has been employed in the company's engineering department at Merriam Park, St. Paul. In addition to his three years' experience in the engineering department, he is a graduate of an Eastern technical school.

J. H. Ainsworth, who has had direct charge of the sales force of the Ohio State Telephone Co., at Youngstown, Ohio, has been made special agent of the company, reporting to the general commercial superintendent. He will specialize on service for large users. Mr. Ainsworth's promotion comes in recognition of splendid service performed in Youngstown, where approximately 4,000 applications for service have been taken in eight months. In leaving Youngstown the salesmen presented Mr. Ainsworth with a very fine solid gold watch. "Jack" is widely known in the telephone fraternity, and with his wide knowledge of the telephone business will undoubtedly do impressive work in his new position.

James G. Wray recently resigned from the position of chief engineer of the Central group of Bell telephone companies and will hereafter be associated with the firm of Hagenah & Erickson, of Chicago, consulting engineers and rate experts. After graduating from the University of Wisconsin, Mr. Wray entered the engineering department of the Chicago Telephone Co., rising to the position of chief engineer of the company. Upon the grouping of the Wisconsin, Michigan, Cleveland, Central Union and Chicago telephone properties into one operating unit, Mr. Wray was appointed chief engineer, from which position he has just resigned to enter the consulting engineering field.

Obituary.

Elery D. Mooar, superintendent of construction of the United Home Telephone Co. in Muskegon, Mich., passed away recently.

From Factory and Salesroom

Conventions: Illinois, Springfield, Nov. 15-17; Canadian, Toronto, Nov. 22-23; Ohio, Columbus, Nov. 23-24; U. S. Association, Chicago, Dec. 5-8; Kansas, Topeka, Dec. 19-21; South Dakota, Aberdeen, Jan. 16, 17 and 18; Minnesota, St. Paul, Jan. 23-25; Wisconsin, Madison, Feb. 6-8; Oklahoma, Oklahoma City, Feb. 19-20; Iowa, Des Moines, March 13-15

Underground Construction Tools and Supplies.

The Brocklen Underground Electrical Specialty Co., of Glenside, Pa., manufactures a complete line of underground electrical construction tools and electrolysis specialties for telephone, telegraph and power companies, known as the "Bee Line." Much has been contributed to the success of the various specialties by its president and general manager, E. L. Brockway, who has had considerable experience in underground construction work. Mr. Brockway has evolved many construction ideas which are now said to be standard practice in underground systems.

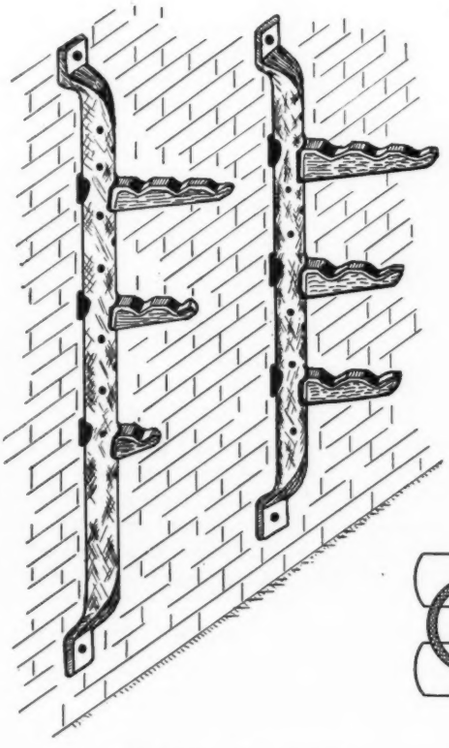
E. L. Brockway.

Graduating in electrical engineering at the University of Illinois in 1898 Mr. Brockway became associated with the Metropolitan Street Railway Co., of New York City. There he superintended the cable construction work involved in changing over the cable tramway system to the present underground system. He later had charge of the underground cable department of the New York City Railways Co. during the building of the New York subways, solving many intricate problems.

It is stated that Mr. Brockway was one of the first to see the need of some means for securing the bond wire to the lead sheath, insuring maximum conductivity. As a result he perfected and patented an electrolysis bond which is said to be giving excellent results. This Bee Line electrolysis bond, which is shown in the accompanying illustration, is declared to overcome several of the ordinarily considered impossibilities. It forms a positive contact on the sheath, the contact being made below the corroded skin of the sheath. The bond conforms to any size cable and protects the lead sheath where the bonding medium enters and leaves. It is stated that there is no danger of melting the sheath in attaching. Direct contact is made by the soldering iron with the bond sheath and ribbon at the same time.

When bonding cables the important features necessary for beneficial results, are a positive low resistance connection to the lead sheath and a conducting medium from one cable sheath to the other. Experience has proved that either copper ribbon or copper tinned wire give the best results. The Bee Line bonds are made to take either the ribbon or the wire, as desired.

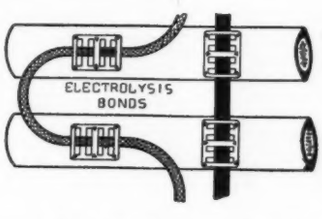
Another one of the company's products is a winch for pull-



Bee Line Cable Hangers.

Lock Coupling Conduit Rod.

Manhole Capstan.



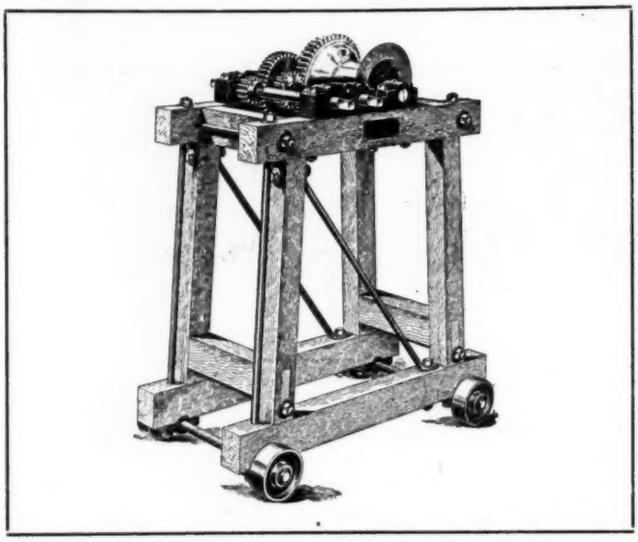
Bee Line Electrolysis Bonds.

Woven Wire Cable Grips.

Some of the Underground Construction Specialties Manufactured by the Brocklen Underground Electrical Specialty Co.

ing cables in and out of conduit. As shown in one of the illustrations, it comprises a compact mortised frame 28 ins. by 42 ins. and 36 ins. high, with or without 6-in. iron rollers. This cable-pulling winch is especially adapted for emergency work and also to meet the average telephone company's requirements.

The Bee Line underground cable hangers are of three types,



Winch for Pulling Cables In and Out of Conduits.

using either pipe supports, bar iron supports or channel rail supports. The hangers permit of vertical and rotary adjustment. The cable may thus be hung in proper shape on these hangers, regardless of the angle of approach of the cable. The rotary feature gives flexibility to the feeders and requires the minimum handling in the work. Instead of bending the cables short to meet the hangers, the hangers are rotated to meet the cable.

The cable supports require only two bolts for fastening to the wall. The hangers are easily inserted or removed on the supports without interference with the other cables in the manhole. They are made with bearing surface for one cable, two cables and three cables and are called the single, double or triple cable hanger. The company also manufactures a single flat hanger for holding a number of small wires on the one hanger.

The Bee Line lock coupling conduit rod, a view of which is shown in one of the accompanying illustrations, was designed by Mr. Brockway to give the direct thrust of the old tried and tested screw rod, but with a lock coupling which is said to give much greater speed. This conduit rod is furnished in any length.

The patent clear vision cable tags, another of the company's products, will appeal to larger telephone companies where many cables are congested in the manholes. These tags are printed in waterproof ink and encased in a brass casing with a transparent top. The numbers and names can thus be seen readily and the water and mud will have no effect upon their legibility.

The company also manufactures a manhole capstan for pulling in cables, as shown in one of the illustrations.

Following are several novel and practical features appreciated by men engaged in underground construction work:

The lead sheath stripper which fits on the manhole frame and through which the cable is drawn as it is being pulled out of the duct.

The manhole dust and water shield which protects the cable from water in the street and from dust and dirt blowing on the splice.

The rain and sun shield, which is attached to the top of the manhole guard.

The collapsible danger stand which fits in the splicer's tool and is light and compact and more attractive than a soiled flag.

Woven wire cable grips for drawing cables in the conduits, are also included in the Bee Line underground construction specialties. The woven wire grip protects the armor and furnishes a uniform strain upon the cable sheath.

The Bee Line messenger bond clamp is made of malleable iron, galvanized. It is so constructed that the bond wire of soft tinned stranded copper is squeezed into a recess made for the purpose by forced contact with the messenger wire.

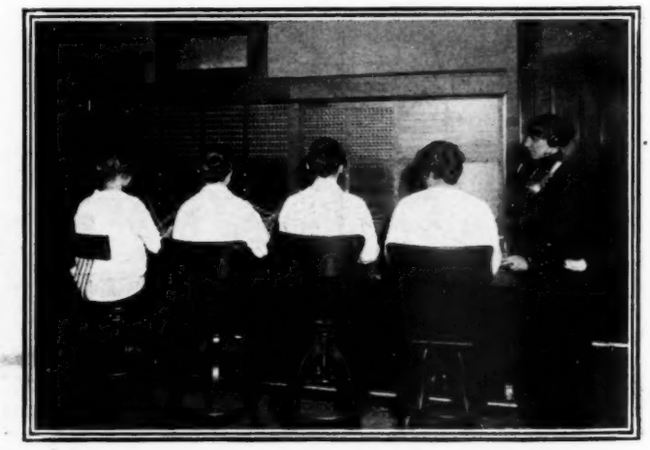
During the past five years Mr. Brockway has visited nearly all of the states, in connection with underground construction work, and thus has had ample opportunity to learn the needs in that line of work and also to investigate new features that have been brought out. As Mr. Brockway has practically grown up with underground work, he should be an authority on the subject. He will be pleased to furnish further information to any telephone men who may be interested, upon request.

New Cracraft-Leich Equipment Installed at Morenci, Mich.

As a rule, the average telephone exchange manager is satisfied if he can render service equal to that of other companies in towns of the same size. But C. E. Smith, general manager of the Morenci (Mich.) Telephone Co. is not an average manager, and while his company was rendering a service equal to if not better than that rendered by other companies in towns of the same population, he was not satisfied. His ambition was to give his subscribers the best service possible.

Mr. Smith spent a great deal of time investigating conditions in the field and examining the various makes of switchboards before deciding that the Cracraft, Leich magneto multiple switchboard was the board to give the desired results. The switchboard installed at Morenci, which is shown in the accompanying illustration, is equipped with the new C-L automatically restoring drops, making it possible to mount the jacks immediately in front of the operator so that any operator can handle any call on the board and automatically restore any signal from her position when plugging in to answer the call.

The restoring feature is said to be positive in operation and the clearing-out signals are also automatic in operation.



New C-L Magneto Multiple Board Installed at Morenci, Mich.

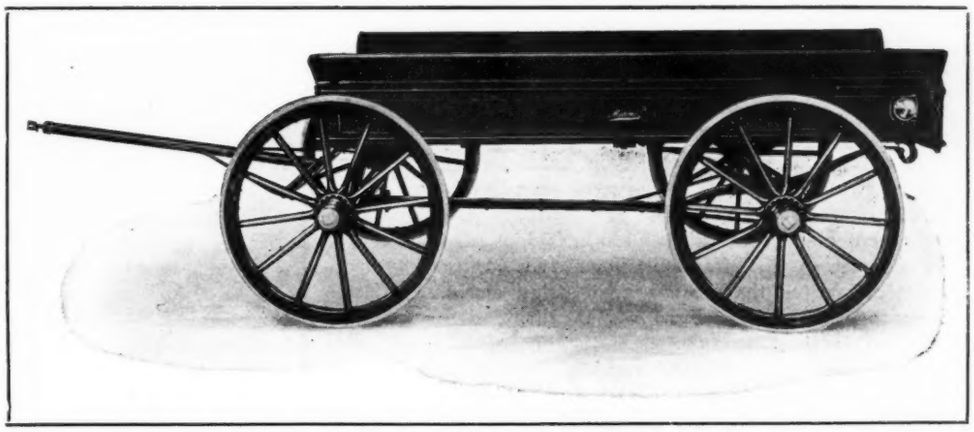
Thus the same speed in handling traffic is stated to be made possible as on common battery equipment.

An average of over 5,000 calls are handled daily by the Morenci exchange and the answering time is said to be less than three seconds. This company's progressiveness has been rewarded by a splendid growth, the exchange showing an average of one telephone for every three and a half people.

Increasing the Automobile's Efficiency in Telephone Work.

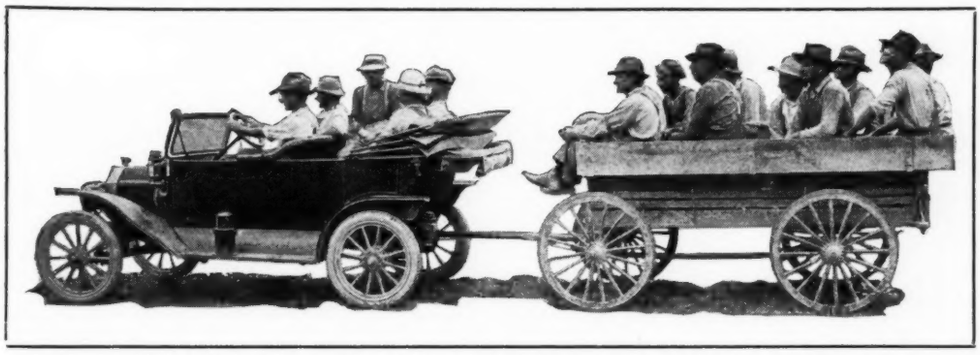
During the past few years the automobile and motor truck have become an important and practically indispensable factor in the plant department of telephone companies, both large and small. Even smaller companies find that a runabout or light weight automobile affords them a considerable saving in both time and money.

Every telephone man, however, is desirous of securing the greatest amount of efficiency from his roadster or automobile. From the service standpoint, the maximum load of a car is not the greater possible load which may be safely carried on its frame, but is the maximum possible load which the motor will pull with the traction furnished by the friction of the rear wheels upon the average road traveled. It is safe to say that this load is far greater than that which can safely be placed upon the frame of the car. It is necessary, therefore, to provide an additional capacity for loading the motor without endangering the frame of the car. The answer is, of course, a trailer.



One of the Four-Wheel Types of Miami Trailers.

By means of a trailer, the construction gang and materials and supplies for a certain job can be transported to the place where the work is to be done. The trailer can then be detached from the car and left for the day or portion of the day required to do the work, while the automobile can be used for other purposes, returning later in the day to haul the trailer back to the company's offices. The trailer thus accomplishes practically the same results as an extra automobile or truck, with small additional cost.



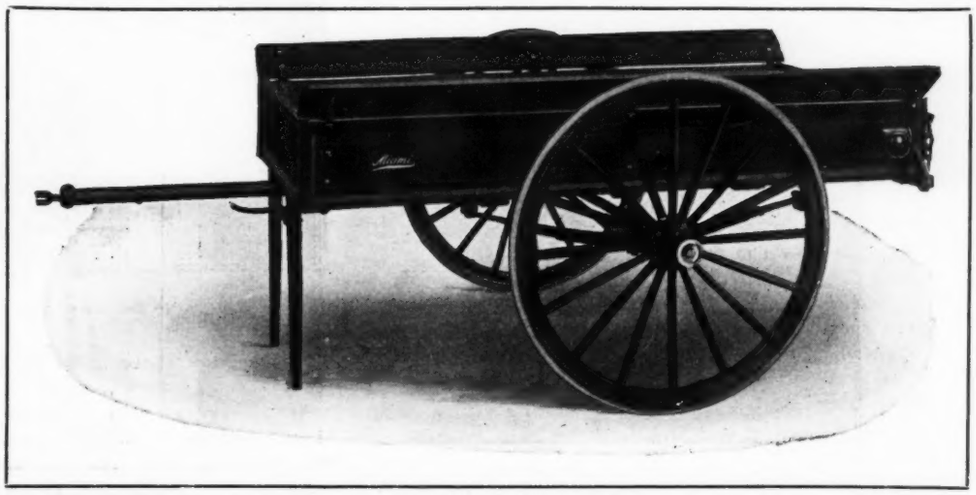
Transporting Workmen by Means of a Miami Trailer Attached to an Automobile.

Any kind of a trailer, however, would not meet the necessary requirements. A lumber wagon tied to the rear axle housing with a log chain, for instance, would not prove very satisfactory. There are certain fundamental requisites which a trailer suitable for use in telephone repair and construction work must have. Among these, the motor and transmission of the car must be protected from excessive jerking; advantage of the spring suspension of the car body should be taken, if possible, and the trailer should be so constructed that it will always track with the automobile. Its capacity will, of course, depend upon the exact use to which it is to be placed, but it should be capable of carrying a load at least as great as the car itself can handle.

The Miami automobile trailer has been used in a number of different lines of work and is said to answer all of the requirements just stated. It is manufactured by the Miami Trailer Co., of Troy, Miami county, Ohio, a company which is devoting its entire time to the construction of trailers and a solution of haulage problems.

The Miami trailers are built in both two-wheel and four-wheel models, with capacities varying from 800 to 2,500 pounds. A special feature is the shock-absorbing draw-bar. The designers of the Miami trailers were especially impressed with the necessity of protecting the automobile from all shocks and vibrations, and this shock-absorbing drawbar has been produced as a result. On this bar the pull is through a spring nine ins. long, operating against a bumper spring five ins. long. These springs compress under 35 pounds pressure.

As an additional precaution, the connection was so de-



A Two-Wheel Miami Trailer.

signed that the bar is attached to the chassis of the machine, thus utilizing the resiliency of the spring-suspended frame. The connection consists of a ball and semi-socket with a leather bushing which fastens by drawing a lever over an eccentric or anti-rattler spring which not only gives a very quick and convenient connection, but also eliminates all noise as well. All models except the smallest are fitted with Timken roller bearings in the hubs. The trailers are simple in construction with nothing to get out of order.

The Miami trailer can also be obtained with a folding extension top, similar to the type used on touring cars, equipped with dust and rain-proof curtains. The telephone construction materials and supplies can thus be amply protected from rain and other elements.

In a letter to the Miami Trailer Co., a contracting firm in Detroit writes that it has been using a No. 2 Miami trailer together with a Ford car for draying on a small scale and for hauling 10 men a distance of 20 miles and that it has given very good service. It has been in use five months and the company states not a dollar has been spent on repairs. Over 2,000 pounds have been hauled without any trouble.

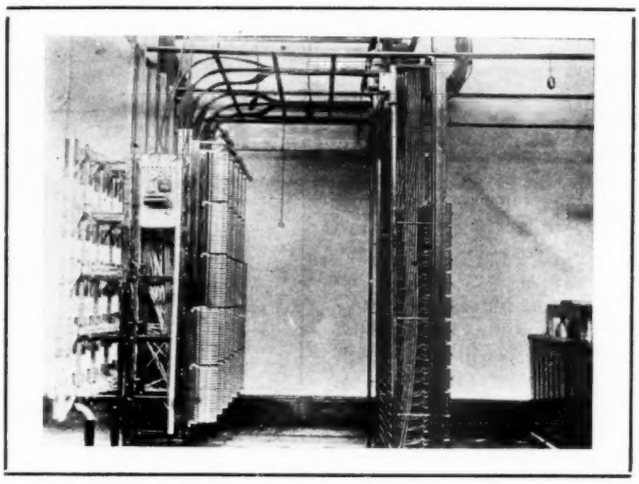
The four-wheel trailer has a body 96 ins. by 38 ins. and 10 ins. deep, with an 8-in. flare board, while the body of the two-wheel trailer is 78 ins. by 38 ins. and 9 ins. deep, with 9-in. flare board. Both types of trailers have drop gates and chains. That trailers add materially to the value of the automobile to a telephone company, cannot be doubted. The trailers are large enough to carry all the materials and tools required on the average repair or maintenance job.

Special bodies are furnished to meet different requirements. Further information will be promptly furnished to those interested, upon request to the Miami Trailer Co., Troy, Ohio.

Kellogg Installation at Concord, N. C.

The new switchboard of the Concord Telephone Co., at Concord, N. C., is a two-section, four-panel cabinet of 540 subscribers common battery lines, with 60 toll and rural lines. The installation included new racks, distributing frame and power equipment. The first position of section one is arranged for combined toll and rural lines. There are four-party master keys for use with ring-back keys and secondary cut-out and telephone switching keys. There are also 15 combination cord circuits arranged for use in making toll to toll and toll to local connections.

The second position of section one is arranged for a common battery position. Fifteen cord circuits are installed, arranged for service with the following features: Eight party automatic harmonic ringing, secret service, instantaneous disconnect and recall. This combination of advantages is claimed to be distinctively Kellogg and to have first been put into practice by the Kellogg Switchboard & Supply Co. There is also a meter service given on completed calls in each position.

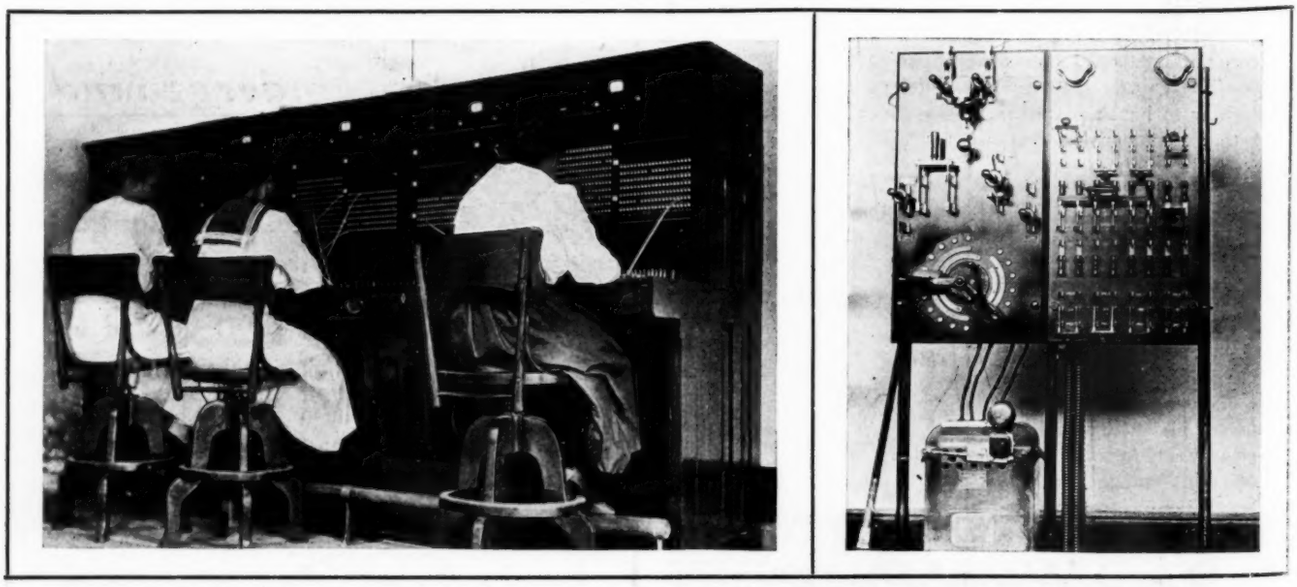


Terminal Room of the Concord, N. C., Exchange.

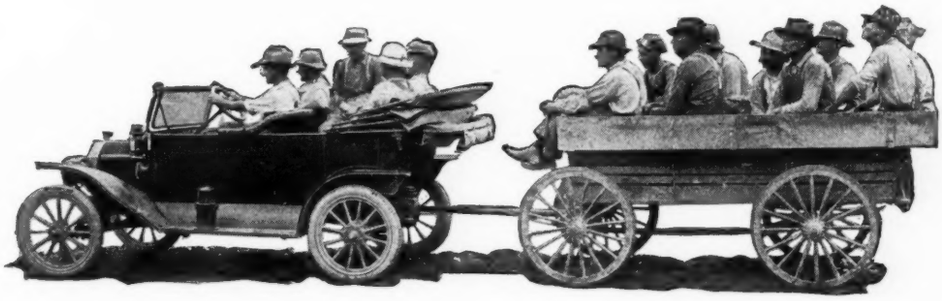
In positions three and four there are 15 common battery cord circuits each the same as just described. A jack equipment is arranged for 60 toll and rural lines with an ultimate capacity of 1,200 common battery lines. The present equipment is 540 lines, as previously stated. At the top of the jack space are mounted the pilot and meters.

A Valuable Aid to the Human Memory.

Persons having many duties which must be performed at a specified time will be interested in a novel device which has just been placed upon the market. The Remindograph, as this device is called, is intended as an aid to the human memory, by calling the person's attention at different



Kellogg Two-Section, Four-Panel Switchboard Installed in Concord, N. C., Exchange—Rectifier and Power Board.



Saving Two Extra 20-Mile Trips With a MIAMI Trailer

The trailer is carrying a load almost equal to double the capacity of the car—can you see the saving?

MIAMI trailers are designed and built for automobile speed—Equipped with Timken axles and roller bearings, artillery wheels, oil tempered springs and special shock absorbing draw-bar.

Trailer tracks perfectly, the special draw-bar eliminates jerking so that both car and trailer ride easily on rough roads. They will outlast your machine.

Submit your hauling proposition to us.
If we can't save you money we'll say so.

THE MIAMI TRAILER CO., Troy, Miama County, Ohio

Andrae Telephones

stand first in quality and workmanship.

The installation of Andrae Telephones mean long and satisfactory service, Telephone efficiency and Battery economy. They are built by pioneers of the telephone industry, to give the Independent Telephone user the maximum of Telephone service.

Andrae Telephone apparatus is absolutely guaranteed.

Send for copies of our catalog No. 34-T and Bulletin No. 16 on Andrae Telephones, Switchboards and Supplies.

ANDRAE — JULIUS ANDRAE & SONS CO. — BROADWAY & MICH. STS. MILWAUKEE. WISCONSIN. — THE HOUSE THAT SATISFIES.

"Cope" Underground Equipment

The Cope CABLE RACK has stood the test for over ten years. Does that not mean something?

The Cope CONDUIT ROD is used extensively throughout every State in the Union.

The Cope BONDING SYSTEM is used by many of the largest telephone companies and central stations in the United States.

Our Catalog explains everything. A postal brings it

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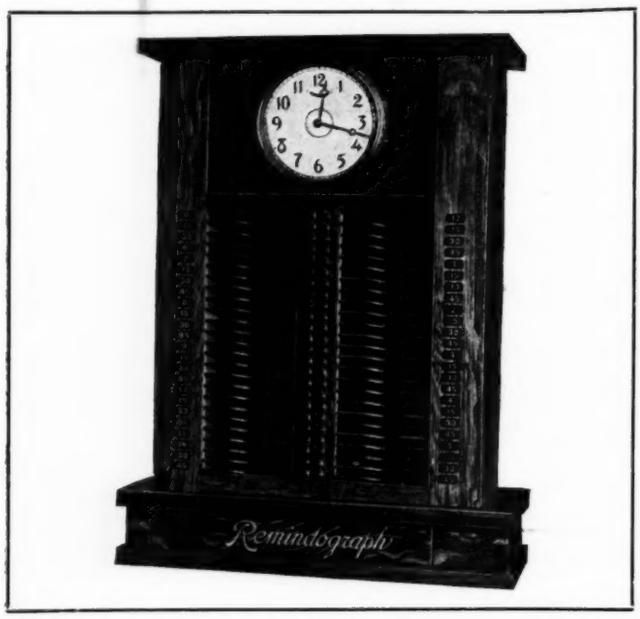
hours of the day or night to a certain duty which must be performed.

Below the clock, which forms an important part of this memory-jogging mechanism, as shown in the accompanying illustration, are provided slots for each quarter hour of the day. In these slots are placed cards bearing memoranda of matters to be given attention at the hour and minute indicated. When the exact time arrives, a small red lamp glows and the whir of an electric buzzer reminds the person that there is something to be attended to. Upon consulting the card he is reminded of the task or detail which needs his attention at that particular time.

The Remindograph is mechanical and electrical in its operations and in addition to furnishing a valuable aid to



Device for Aiding the Memory.

the memory, provides a reliable timepiece. It is attractive in appearance and can be obtained either in golden oak, ebony or mahogany.

This device is being marketed by the Automatic Remindograph Co., whose offices are located at 431 South Dearborn street, Chicago.

Book Reviews.

PRINCIPLES OF THE TELEPHONE; PART I, SUBSCRIBERS' APPARATUS, by C. M. Jansky and D. C. Faber. Published by McGraw-Hill Book Co., New York; 160 pages, 125 illustrations. Price, $1.50 net.

This volume is the first of a series of three which are to be issued under the general heading of "Principles of the Telephone." It deals mainly with the subscriber's apparatus, while the other two parts, which are in preparation, will consider central office equipment and outside construction.

The authors, who are professors in the University of Wisconsin, took every advantage of contact with men engaged in the industry in order that the text matter might appeal to and be of practical use to men actively engaged in the installation, care, and operation of telephone apparatus. It was their purpose to clearly set forth the principles that underlie good construction and not to give details to any extent.

The main emphasis, however, is placed upon the principles of operation of different types or makes of subscriber's apparatus, together with a discussion of methods of locating faults and their correction. The general principles covering the piece of apparatus to be discussed are first given and then follows a description of several makes of the apparatus showing how the principles have been applied by the manufacturers whose equipment is described.

The introductory chapter gives a historical résumé of the telephone and a brief outline of its operation, with definitions of the various parts of the subscriber's apparatus. Elementary electrical principles are then discussed as they relate to telephony. The magnetic relations as applying to telephone receivers, furnish the basis of discussion for another chapter. The points are fully brought out by suggested experiments.

Before taking up the discussion of transmitters, the subject of sound is considered. After the principles of telephone receivers and induction coils are stated, with examples of typical constructions, the signaling apparatus and circuits are then taken up. This naturally leads to a discussion of the subscriber's telephone, both local and common battery.

The faults usually found in substation telephone apparatus are next considered with full instructions as to their locations. Protection as required for subscriber's equipment is quite fully treated, after which installation information is given.

After a discussion of the various kinds of ringing for party lines, attention is given to intercommunicating systems.

Throughout the book, examples, experiments and drawings are used to make clear the principles. Each chapter has a set of questions, by means of which the student can test his knowledge of the principles set forth. The book will undoubtedly be of great assistance to those desiring to gain a knowledge of the principles of the subscriber's station apparatus and its operation.

ELECTRICAL TABLES AND ENGINEERING DATA, by H. C. Horstman and V. H. Tousley. Published by Frederick J. Drake & Co., Chicago; 331 pages, 4½ ins. by 6½ ins.; 130 tables. Price $1.

Tables and practical hints for electricians, foremen, salesmen, solicitors, estimators, contractors, architects and engineers, are found in this book which is intended for refernce while on actual work. For that purpose the book is of a size adapted for carrying in the pocket. There are no theoretical discussions and only those tables and data are presented that are commonly sought in everyday work and but seldom available when needed. The tables are arranged in alphabetical order so as to be readily found when wanted. Wire tables of all kinds and construction data with explanatory notes are presented in a practical manner.

Those interested in electrical work in its practical aspects will find considerable value in this book that will be of aid to them in their work.

ELECTRIC MOTORS, DIRECT AND ALTERNATING, by D. P. Moreton. Published by Frederick J. Drake & Co., Chicago; 241 pages, 4½ ins. by 6½ ins.; 115 illustrations. Price $1.

Fundamental principles of electrical and magnetic circuits are treated in the first three chapters of this book in order that the reader may readily appreciate their practical applications in the various types of direct and alternating current motors. After a discussion of the common methods of electrical measurements, with special reference to the requirements of the practical man, armature windings for direct and alternating current motors are considered. The construction, operation and maintenance of direct current motors are then taken up, after which attention is given to the various types of alternating current motors.

Though intended for the practical man, the book will be of value, also to the student and those desiring to become familiar with the practical side of motor work.

Improvements Under Way at San Bernardino, Cal.

The Home Telephone Co., of San Bernardino, Cal., is making numerous improvements to its system, including the placing of underground cables in the business district of the city, at an expenditure of approximately $10,000.